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STREET RAILWAY STATISTICS are given as follows by the *Street Railway Journal:* The total number of miles of street railways in the United States and Canada is 11,029, of which 5,442 are operated by animal power, 3,000 by electric power, 1,913 by steam power, and 660 by cable power. The total number of cars employed in the street railway traffic of the United States and Canada is 36,517, of which 25,424 are operated by animal power, 6,732 by electric power, 3,317 by cable power, and 1,044 by steam power. The total number of companies operating street railways in the United States and Canada is 1,003, of which 412 operate electric lines and 54 operate cable lines. The number of horses employed in street car service is 88,114, of mules, 12,002, and of steam motors, 200. It is interesting to note that since Nov., 1890, the number of horses employed on street railway lines has fallen from 110,795 to 88,114; that is, 28,681 in one year.

THE INTERCONTINENTAL RAILWAY COMMISSION reports as follows, under date of Sept. 15, of the several surveying parties: Corps No. 1, Lieut. M. M. MACOMB, U. S. Army, in charge, sailed from New York April 20, 1891, and arrived at Guatemala City May 9. The other officers of this party are Lieutenants FOOTE, KENNON, ROWAN, REBER, HEDEKIN, U. S. Army, and Mr. C. W. HAINES, with Surg. W. C. SHANNON, U. S. Army, as medical officer. The corps has since been augmented by the detail of four engineers whose services were tendered by the Government of Guatemala. Under date of July 29, 1891, Lieutenant MACOMB reports that he is working toward the Mexican line, being encamped near Patulul. After completing the survey from Guatemala City to the Mexican line he will return to Guatemala City and proceed southward with the survey through Central America. Corps No. 2, in charge of Mr. WILLIAM F. SHUNK, sailed from New York April 10, 1891, and arrived at Guayaquil April 21, and at Quito May 7, 1891. The assistants in this party are ROBERT BURGESS, WILLIAM J. O'CONNELL, JAMES PARKER, THOMAS F. DEMPSEY, D. M. MARTINEZ, JR., and Surg. FRED. N. OGDEN, U. S. Navy. Under date of July 12, from Ibarra, Ecuador, Mr. SHUNK reports that he left Quito June 3, and, although this is considered the most difficult part of the route, he had made an average of about 2½ miles per day, and at the time of writing was making about 4 miles per day, with the hope of increasing that speed. He estimates the average cost of the first 100 kilometres, for grading, masonry and bridges at $20,000, equivalent to about $32,000 per mile, and he had not used any gradient exceeding 3%, which is about equal to 150 ft. per mile. Corps No. 3, in charge of J. IMBRIE MILLER, accompanied Corps No. 2 as far as Quito and then commenced surveying to the southward toward Peru. The other members of this party are WILLIAM D. KELLEY, JR., W. L. WILSON, J. D. FOSTER, J. R. KURTZ (the latter sailed to join the party on the 10th of August), and Surg. C. W. RUSH, U. S. Navy. Mr. MILLER reports, under date of July 14, that his party was then 100 miles south of Quito, and a cablegram informs us that he had reached Cuenca, 160 miles south of Quito, on Aug. 1; this is near the Peruvian boundary. He expects to maintain a speed of 100 miles per month over the route.

THE CATARACT CONSTRUCTION CO., which is engaged in a great water power development scheme at Niagara Falls, has an imitator on the Canadian side, which, according to reports to us, is far from being a *bona fide* enterprise. The Canadian scheme purports to be to build a canal and tunnel from the Chippewa River, on the Canadian side, to Queenstown, a small town of about 100 inhabitants, located on the brink of the chasm, about 8 miles below Niagara Falls. Surveys have just been made for this work by Mr. THOS. M. GRIFFITH, of 87 Liberty St., New York City, who found that about 6 miles of tunnel and 2 miles of open cut would be necessary. As may be imagined, a very considerable capital would be necessary to carry out the scheme, and the only apparent reason for going so far below the falls is that the projectors of the enterprise secured options on some farming lands at Queenstown, and proposed to cut them up into town lots. The party at the head of the scheme is said to be one JAS. R. ROOF, of Toronto, who has also opened negotiations with the Lockport Business Men's Association with reference to the construction of the proposed water power canal to supply that city, and has been negotiating with parties at Lewiston, N. Y., opposite Queenstown, concerning the building of a water power tunnel from a point above Niagara Falls to Lewiston.

As noted last week, Mr. CHAS. B. BRUSH has reported upon the Lockport enterprise, estimating the cost at $9,000,000; and, as Lewiston is some 7 miles below the falls, the cost of that enterprise, also, would hardly be small. The ability of Mr. ROOF and his associates to carry out even the preliminary work on all or any of these schemes seems rather doubtful, as Mr. GRIFFITH informs us that he has been able to collect nothing from them for his services, nor for the workmen employed to assist him. As the "syndicate" may try to employ other engineers, we have given this space to describe their operations, and would suggest that any one before making an engagement should correspond with Mr. GRIFFITH or investigate more fully at Lewiston and Queenstown for themselves.

NO VERY SERIOUS RAILWAY ACCIDENT has been reported this week. Three freight train accidents occurred in which the trains broke apart, and the sections came together again with such force as to wreck the cars. The first of these was on the Southern Pacific Ry., near Baden, Cal.; a fast freight and cattle train broke on a down grade, and, being unprovided with automatic brakes, 4 or 5 cars were wrecked, and about 300 sheep killed. Another was at Columbus, Wis., on the Lacrosse division of the Chicago, Milwaukee & St. Paul R. R., in which 1 man was killed and 11 cars were wrecked. The third was on the Boston & Maine R. R., at North Berwick, Me., Oct. 5.

THE IMMENSE ELECTRIC POWER PLANT, for the West End Street Railway Co., of Boston, is nearing completion. The boiler house is 160 ft. by 80 ft. and will contain 24 boilers supplying 13 triple expansion engines of 2,000 HP. each, or 26,000 HP. capacity for the completed stations. This added to the capacity of the Cambridge station gives a total of 34,000 HP., sufficient to run 1,700 long cars. This plant, however, is only half finished as yet. The generators, which are being put in by the Thomson-Houston Co., will demand one of the most elaborate and extensive systems of counter shafting ever built.

A FAST RUN ON THE BALTIMORE & OHIO R. R. was made Oct. 4. The Royal Blue Line train, made up of one combination car, two passenger cars and a Pullman parlor car, was detained by a fire in Canton at Baltimore. The run from Canton to Newark, Del., 54.4 miles, was made inside of 56 minutes, including a 2-minute stop. From Newark to Philadelphia, 37.2 miles, the time was 36 minutes, including stops at Wilmington and Chester. A speed of 72 miles an hour is said to have been made at times.

ALUMINUM, substituted for cast iron in the tower of the new public buildings in Philadelphia, will save 400 tons in weight and avoid the constant expense of painting. It is reported that the new metal has been definitely adopted for this purpose by the commissioners.

THE SOUTHERN ROAD CONGRESS will meet in Atlanta, Ga., on Oct. 28 next, with the general object of improving the highways of the South, and especially to discuss the construction of permanent roads.

AN ASSOCIATION OF GOVERNMENT GEOLOGISTS is promised as an outcome of the late geological congress in Washington. A preliminary meeting held at the Columbian University was attended by many of the most prominent geologists in this country, and Major J. W. POWELL was elected Chairman, and Mr. ARTHUR WINSLOW, State Geologist of Missouri, Secretary. Mr. WINSLOW was instructed to draft a constitution and by-laws, to be submitted to the committee at the annual meeting of the Geological Society in December next. All state geologists are invited to the meeting.

CREOSOTE WORKS for rendering piles proof against the teredo will probably be built in San Francisco at a cost of about $100,000. At least, the Harbor Commissioners have ordered Chief Engineer MANSON to prepare plans and specifications for works of this character.

A PARAGUAY RAILWAY has been authorized by the Congress of that state, and a concession granted to Viscount de ALBERT. The road would run due west, in the 25th parallel from Asuncion, in Paraguay, to Curitiba, in Brazil, a distance of 525 miles, and then southeast, 110 miles, to Santos, on the Atlantic coast. This line would save thousands of miles of sea and river transportation, and from Santos, one of the finest harbors on the Atlantic, about three-fourths of the entire coffee crop of Brazil is now shipped.

AN AIR-SHIP WHICH GENERATES HYDROGEN GAS is to be tried by HENRI LE COMTE, the director of the school of aerostation in Paris. He is credited with proposing to cross Africa, from Mozambique, by this balloon.

THE ARMORY ST. GRADE CROSSING, in Springfield, Mass., is to be abolished, and an iron viaduct will be substituted, which is to be 405 ft. long and 49½ ft. wide. This is by order of a commission appointed one year ago. The official order minutely specifies the structure demanded.

AN ELECTRIC RAILWAY SYSTEM is said to have been invented by Mr. EDISON which does away with many of the objectionable features of the overhead wire system, and can be applied to any railway at a third of the cost of a cable road. Only the rails are used, and there is no slot. The principle of the invention consists in the application of the current, and the current, the inventor says, can be picked up through 2½ ins. of mud. The regular motors would be used under the street cars, the current being taken directly from the rails. We referred on page 286 to the field open for the introduction on city streets of a practicable and economical system of electric traction which will not require the use of overhead wires.

THE KHOJAK PASS TUNNEL, on the borders of Afghanistan, is finished, says a Calcutta letter to the New York *Tribune*. This tunnel was commenced in December, 1887, and it is about 2¼ miles long. The total cost is given as being 152 lacs of rupees, or about $5,000,000. Work upon it was attended with great difficulties, as the rainfall sometimes reached 40 ins. in 4 months, and the temperature in winter fell to 24° below zero. Out of 4,000 natives employed 1,000 are said to have lost their lives.

The Stampede or Cascade Tunnel on the Northern Pacific R. R.

BY CHARLES W. HOBART.

(*Concluded from page 303.*)

By the terms of the contract, the Cascade tunnel was to be 16½ ft. wide in the clear, and 22 ft. in height, and was to be completed by May 21, 1888, or 28 months from the date of the contract. As we have seen, about six months of this had passed before the machine drills were put in operation, thus leaving but 22 months for the actual boring of 8,950 ft. of tunnel, 900 ft. having been driven with hand drills during the first six months.

The method of driving the tunnel was as follows: An 8-ft. heading was driven along the top of the tunnel and was kept about 30 ft. in advance of the bench where the tunnel was excavated to its full size. With the exception of about 500 ft. inward from each portal, where the rock was firm and stable, the entire tunnel was timbered as fast as the work progressed. The timbers of the heading rested upon the bench, and as that was removed other timbers were put in its place.

The Arlberg tunnel in the Alps was driven by a bottom heading, and at intervals of 100 ft. a shaft was driven upward from this heading to the top of the tunnel section and a top heading 6.56 × 8.2 ft. was then driven each way from this shaft along the crown of the tunnel. All the work except driving the bottom heading was done with drills. [See ENGINEERING NEWS, Jan. 19, 1884.] This made an extremely rapid system of tunneling and a very expensive one as well. As economy of money as well as time was urgent at the Stampede tunnel, the ordinary top heading system was used.

The work on the Stampede tunnel was under the superintendence of Capt. SIDNEY J. BENNETT, a brother of the contractor, and a detailed report was made daily to Mr. NELSON BENNETT at his office in Tacoma. From the time the machinery was placed in full operation at the tunnel until its completion, the average number of men employed at the tunnel was 350. They were employed by the day of 10 hours, and were paid from $2.50 to $5 per day, according to the character of work and the skill required, wages being paid regularly and promptly at the end of each month. Eating and lodging houses were established by the contractor near the portals of the tunnel, where the men were boarded at 75 cts. per day. In addition to the daily wages a bonus was paid to all men working inside the tunnel, as follows: For every foot gained during the month over the necessary average of 13.58 ft. per day, each laborer, doing continuous duty through the month, was paid 25 cts. extra, and each drill man or expert workman was paid 50 cts. extra.

Work was carried on every day and night in the year, requiring two shifts in each end, each composed of about 75 men. Besides these workmen there were the engineers, firemen, carpenters, machinists, etc. The monthly pay roll amounted to about $30,000.

From the daily reports to Contractor BENNETT, the following extracts are noted:

Feb. 15, 1886.—Work on excavation on approach to tunnel at west end will be prosecuted until point of heading is reached.

March 15.—Thirty-six inches of snow fell within the last 36 hours.

March 21.—Rained for the last 24 hours.

March 27.—Began work on the "bench" inside of the east portal.

March 31.—Commenced timbering; put 12 sets in, the first used.

April 1.—Sixty men worked in east end; completed excavation of the approach to the heading at the west end.

April 2.—Commenced running the heading of the west end. The extent of the day's work was 5½ ft., by hand drills. The excavators at the east end have made to this date 200 ft.

April 6.—Rock harder, blue trap in west end.

May 1.—Snow retarding the work in the east end cut.

May 5.—The first man was injured; it was by a falling rock.

June 19.—Two Ingersoll drills started in east end.

July 24.—About 150 men in east end struck for nine hours as a day's work. It lasted two days, but did not prevail.

In this matter the sheriff of the county was called upon the ground to prevent disorder and injury to persons or property. One man was shot by him in his attempt to escape from arrest under a criminal charge.

Aug. 9.—Electric lights were extended in the west end, having been previously placed in the east end. The rock in the east end is getting so hard that it has to be blasted with No. 1 giant powder.

Aug. 18.—One man killed and another injured by blasting.

Sept. 1.—Three Ingersoll drills started in the west end.

On this day, Sept. 1, 1886, a computation was made of the daily progress necessary to complete the work within the contract time. It was found that an average progress of 13.58 ft. per day must be made to complete the work within the contract time. At the end of September, however, it was found that the progress had been 33 ft. less than this rate. Continuing the extracts:

Sept. 5.—Work was advanced so far that the smoke and gas incident to the blasting, had to be remedied. The steam fans were applied, which materially aided in clearing the tunnel.

Sept. 25.—Drilling was delayed because of the breaking of rock above the line of the tunnel, caused by blasting, which it took five days to remedy.

Oct. 15.—Air boxes were extended 265 ft. in the west end.

Oct. 29.—The tunnel is in bad shape; the roof is cracking and rock is falling, which causes delay. [During the month of October a gain of 17 ft. was made over the daily average required.]

View of West Portal of Cascade Tunnel.

Nov. 1.—A foreman and five men have quit because of some grievance and left camp.

Nov. 15.—Snow sheds had to be built over the dump track.

Nov. 25.—Seventeen cords of wood used in the east end of the tunnel for packing behind the timbers.

Nov. 29.—A land slide into the crib became so extensive we had to stop work in east end for a week, which delays progress.

During November the progress was 23½ ft. less than the necessary average, and in December the work was delayed by rain, which flooded the east end, and the total progress was 9 ft. short. It will be remembered that the drilling machinery did not get into operation at the west end until Sept. 1. Work in the east end with machine drills began about 70 days earlier, making an average of about five months of machine work in the tunnel during 1886. The progress made to the end of the year was 48 ft. short of the average required. In January, 1887, there was a gain in the rate of progress over the required average of 24½ ft.; but in the seven following months the progress was 300½ ft. below that required, so that on Sept. 1 there was 410 ft. to be made up. The greatest loss was in May, 1887, when the progress fell 146 ft. short of the required amount. This was chiefly due to the flooding of the tunnel, the bad condition of the bottom and the quitting of workmen.

But the difficult task of making up this time was successfully accomplished. In the eight and a half months, from Sept. 1, 1887, to the completion of the tunnel, May 14, 1888, there was a total gain of 454½ ft. over the regular progress at the rate of 13.58 ft. per day. The greatest progress in any one month was made in April, 1888, when the total advance in the two headings was 540 ft., an average of 18 ft. per day.

The rapid advance in the rate of progress of the work during the latter part of the time was due partially to the removal of the local engineer under whose immediate direction the work was begun, between whom and the contractor's superintendent there was some friction. A change was demanded of the railroad company by the contractor, in order that the progress of the work might not be jeopardized; and after it was made the advance in the rate of progress, noted above, made possible the completion of the tunnel in advance of the schedule time.

During the progress of the work there was no little rivalry between the forces working at the two ends to see which would make the greatest daily progress, and also do the largest portion of the whole work. This gave a stimulus that added considerably to the rate of progress.

The accompanying table shows the progress per month in feet from the beginning of the work; and the same information is given on the progress profile. The length of the tunnel from portal to portal is 9,850 ft.—710 ft. short of two miles. Of this distance 899½ ft. was driven by hand drills, leaving 8,950½ ft. to be driven by the machine drills. Averaging the time during which machine drilling was carried on at the east and west ends we have 21⅝ months as the time spent in driving this distance, making the average rate of progress 413 ft. per month.

TABLE SHOWING MONTHLY PROGRESS IN FEET ON THE STAMPEDE TUNNEL, NORTHERN PACIFIC R. R.

	1886.				1887.				1888.			
	West End.		East End.		West End.		East End.		West End.		East End.	
	Headings.	Bench.	Headings.	Bench.	Headings.	Bench.	Headings.	Bench.	Headings.	Bench.	Headings.	Bench.
Jan.	....	....	....	....	225	208	226	220	262	278	218	209
Feb.	....	....	71	....	220	214	137	150	254	270	251	275
March.	....	....	121	24	190	201	216	206	273	259	258	260
April.	75	....	136	104	190	187	167	158	258	270	259	255
May.	168	....	70	102	146	160	123	147	30	66	32	72
June.	138		31	172	193	187	127	106	....	....	....	....
July.	101	35	202	152	190	189	190	198	....	....	....	....
Aug.	....	425	191	200	230	204	185	165	....	....	....	....
Sept.	228	200	157	195	211	228	217	190	....	....	....	....
Oct.	259	262	178	162	254	251	207	246	....	....	....	....
Nov.	241	240	143	158	255	262	242	250	....	....	....	....
Dec.	213	221	196	182	274	248	225	218	....	....	....	....

On May 3, 1888, the drilling forces in the headings met at a point about midway of the tunnel, and the line and levels carried in from each end by the engineers were found to check with a variation of less than an inch. On May 14 the excavation was completed, seven days before the expiration of the contract time. The railroad track was laid through within the next two days; and the tunnel was cleared out and put in shape for use. On May 22 the first regular trains ran through the tunnel.

The total amount of blasting powder used in the tunnel for the entire work was 6,192 boxes of 50 lbs. each, making a total of 309,625 lbs. This explosive was of several different grades, as shown in the following table:

Kind of Explosive.	Nitro glycerine contained, per cent.	No. of 50-lb. boxes used.
Giant No. 1	60	403¾
Giant No. 2	45	2,173½
Hercules No. 1	60	1,503½
Hercules No. 2	45	1,781¼
Nitro glycerine No. 2	..	232
Forcite No. 2	..	41½
Total		6,192

The use of powder by months for the first months of 1887 was as follows: January, 439 boxes; February, 308½ boxes; March, 324 boxes; May, 269½ boxes. The average price paid for all explosives was $10 per box.

Considering the character of the work, the number of men employed, and the fact that it was in progress over two years, accidents were remarkably few. The total number killed during the progress of the work was 13. A hospital was established at the tunnel where sick and injured workmen were cared for at the nominal rate of $1 per month.

To Mr. E. H. MCHENRY, now principal assistant engineer of the Cascade or Western division of the

Northern Pacific R. R., the writer is indebted for the official maps and profiles of the tunnel and its surroundings published herewith. To Mr. McHENRY belongs the credit for the engineering work on the tunnel, as he had entire control of the work during the greater part of the period through which it extended.

Credit should also be awarded to Gen. ADNA ANDERSON, Engineer in Chief of the Northern Pacific R. R. Co. at that time, for the general supervision of the work. The following data concerning the work were furnished to the writer by Mr. ANDREW GIBSON, employed as assistant engineer in the construction of the tunnel, and now in charge of the work of lining it with masonry.

The American method or center cut system was adopted, and in blasting from 20 to 23 holes averaging about 12 ft. in depth were made in the headings and about 18 holes of the same depth in the benches. Each drill would make, in medium hard rock, 6 or 7 holes in 5 hours. There were times, however, when an exceedingly hard layer of rock would be struck and it would take as much as 15 hours to accomplish the same work. About 400 lbs. of powder were generally used at each blast in each of the headings and benches. This would break usually from 8 to 12 lin. ft. of tunnel rock. At times, however, in very hard rock only about 4 lin. ft. of heading and about 6 ft. of bench would be broken at a blast.

The headings were taken out full size, so that the arch timbering was carried forward on the bench to within about 20 ft. of the face of the headings, when the rock was of a character to require this for safety.

The rock through which the tunnel is driven is of a basaltic character, with a dip of the strata toward the west of about 5°. It was necessary to place permanent timbers close to the headings by means of wall plates, the dip of the strata and the general lack of tenacity of the rock rendering it not sufficiently strong to sustain itself in the roof of the tunnel. The placing of this permanent timbering required great care, and necessitated compact packing of wood and wedging to secure a continuous bearing upon each segment and make all safe. The timbering necessitated a delay of the drilling and clearing forces or "muckers" of about one-fourth the time, an important matter when time was the vital thing, as in this case.

During the period of hand drilling the number of men employed in each heading averaged about 17 with about 23 muckers, and the daily progress made was about 4 lin. ft. of tunnel per 24 hours. During the period of air drilling the number of drills used averaged 5 per day in each end, or 10 in both ends, and the progress made was about 13.8 lin. ft. per day of 24 hours, or 6.9 ft. per heading.

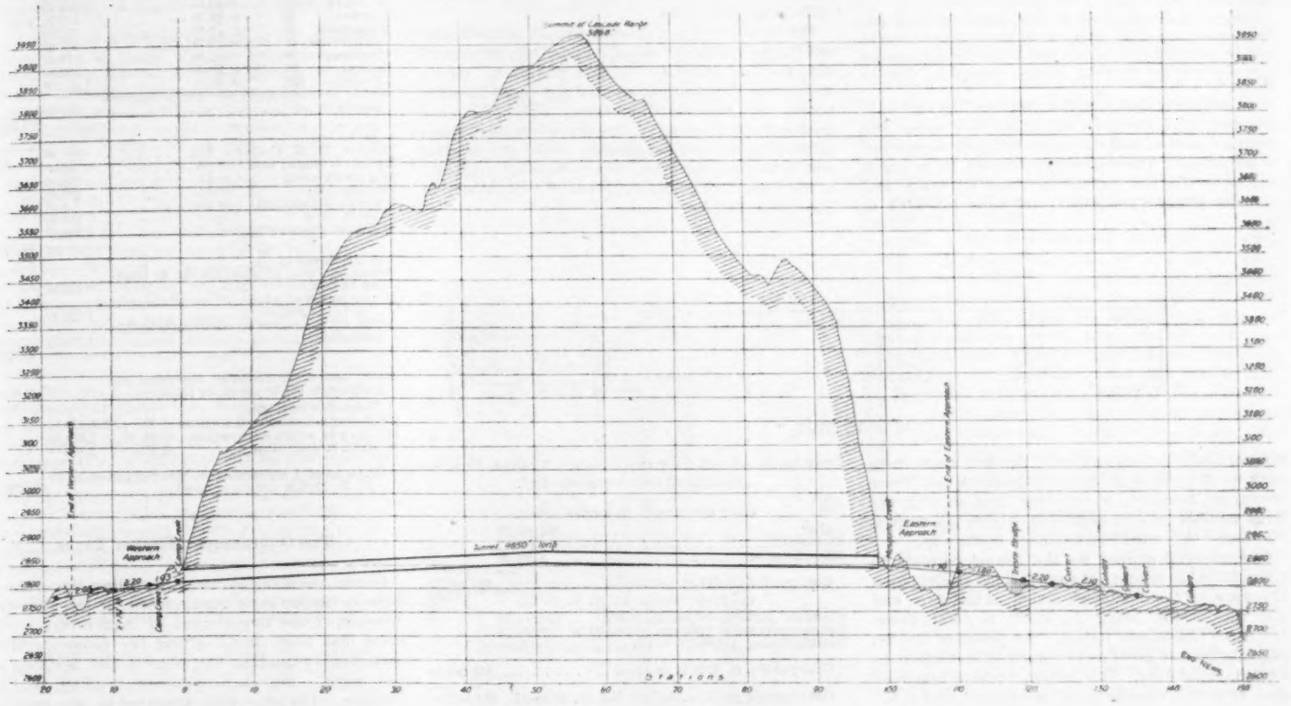
While the contract size of the tunnel was, as elsewhere noted, 16½ ft. wide, and 22 ft. from subgrade to face of arch, the timbered sections had to be excavated 19⅓ ft. wide and 23 ft. 10 in. high, thus requiring 15.70 cu. yds. more of rock to the lin. yd. to be taken out than in the sections where no timbering was required.

The timbers used for posts, segments and wall plates throughout the tunnel were 12 × 12 ins., and the sills were 8 × 12 ins. Five segments were used in the arch, covered with 4 × 6 in. pieces. The vacant spaces above these to the rock roof were filled with cord wood and other solid packing. The spacing of the bents was according to the character of the rock, but was generally from 2 to 4 ft.

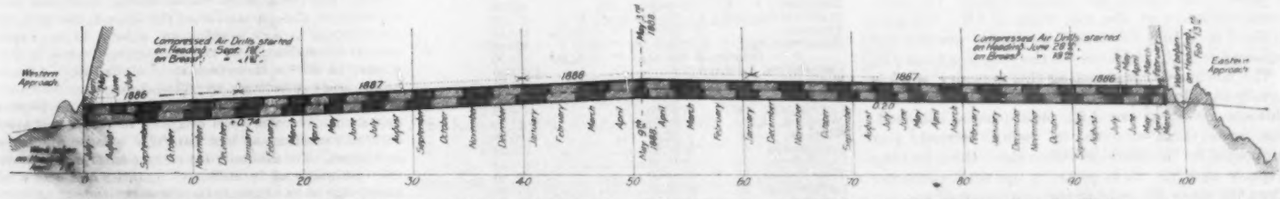
One great obstacle usually found in tunnel work, the presence of underground water, gave little trouble here, except at the portals. In fact, only one spring of any importance was found in the entire length of the tunnel. This was encountered about 2,000 ft. from the east portal, and its water was led to the side ditches and got rid of without trouble.

Until the work had extended into both ends of the tunnel about half a mile, mules were used to haul out the dump cars of broken rock. Beyond this point small locomotives were used as the motive power, the grade being so very light that they could haul eight to twelve cars, thus making the cost of hauling out the débris comparatively very light. In mucking out the benches, cars were run up close enough to shovel the rock into them. In taking out rock from the headings, gang planks were used, extending from the top of the benches to a carriage composed of two frame bents, each being upon two wheels, about 18 ins. diameter, resting upon rails 16 ft. apart. These bents were connected at the top with 12 × 12 in. caps extending from one to the other, and were strongly braced from caps to bent posts. A platform was built with 4 × 12 in. planks, on top of which drills, shovels, etc., were placed when not in use. Under this carriage two cars were placed under two openings, through which the rock from the headings was dumped with wheelbarrows. Of this carriage Mr. BENNETT says:

> It was used during the construction of the entire tunnel, and we found it a great convenience in expediting the work. The projection leading to the heading was 20 ft. in length. The men wheeled the rock from the heading directly on to the platform of the carriage, dumping into a car that stood behind the car used for the bottom or lower work.



PROFILE ON LINE OF TUNNEL.

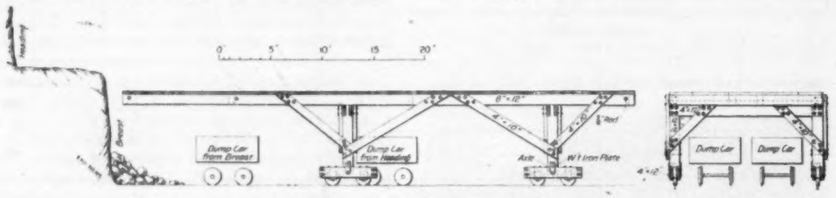


LONGITUDINAL SECTION OF TUNNEL SHOWING PROGRESS BY MONTHS ON HEADING AND BREAST.

As seen by the end elevation, this carriage straddled both tracks in the tunnel, and was operated on a separate rail altogether. Before blasting, the men loaded all their tools, etc., upon this carriage, and ran it back from the face for some distance. After a blast they ran it forward again. Thus the men could get to work just as soon as the face had sufficiently cleared of gas and smoke to enable them to find the way. The upper, or heading, work never interfered with the lower, while both could be carried on simultaneously. It was a great convenience also in timbering as well as in the manipulation of the electric lights, etc.

I attribute the rapid work in this tunnel very largely to this device; and while there is no doubt that it can and will be greatly improved, we had no trouble in operating t as shown in the drawing. The men named it "The Go Devil."

As originally designed this carriage had two endless belt conveyors, one extending out along the front projection, and the other inclined downward to the breast. These were to be driven by a steam engine on the rear of the carriage by chain and sprocket wheel connections, and were intended to



THE "GO DEVIL."

automatically convey the rock thrown upon them back to a hopper emptying into the dump car. These conveyors, however, were never used, as with the large number of men employed to push the work it was found they would be too much in the way.

The material pierced by the tunnel consists, to a considerable extent, of shale, which swells upon exposure to the combined action of moisture and air, the result being to exert a great pressure upon the timber lining. The pressure has repeatedly been so great as to reduce 12-in. timbers to a thickness of 4 ins. This action became apparent soon after the completion of the tunnel, and it became evident that permanent lining would be necessary. After careful consideration it was decided that a lining of such character as would exclude the air from the shale would prevent the swelling; consequently that it would not be necessary to provide masonry to resist the forces communicated by the swelling material, and its action upon the timber lining. This having been decided, work was at once commenced, and has been in progress ever since under the immediate direction of the company. The material used in this masonry lining is concrete for the walls and brick for the arch. The concrete is composed of broken stone 5 parts, sand 2 parts, and cement 1 part. The minimum thickness of the side walls is 3 ft. The arch is lined with best brick laid in cement mortar, and at no point is the thickness of the ring less than 2 ft.

The method of constructing this masonry work is briefly as follows: Where the spaces between side timbers or posts are 4 ft., one post is removed, the arch timbers over it being braced and supported by the posts on either side; thus leaving a space of 7 lin. ft. to be built up with concrete. Then the posts adjacent to the one removed are left in place and the posts next beyond them on either side are taken out. This operation is continued until several 7-ft. sections of timber are removed, and the concrete built up in their place has become sufficiently hard to support the arch timbers—say in eight or ten days. On these concrete supports the arch timbers are then blocked up; and the remaining posts are taken out and their spaces filled solid with concrete, thus making the wall continuous. Two-inch plank, held in place by false posts, are used to hold the concrete in place while it hardens. The mortar for the concrete is prepared outside, and is taken into the tunnel on platform cars having their floor on a level with the top of the walls. On either side of the cars are two spouts, and when the mortar is ready for use the gates of these spouts are raised and the mortar runs into the space behind the plank with no shoveling. The broken rock is then brought in on flat cars, shoveled into the mortar and mixed with it.

The work is carried on under difficulties, of course, due to the interruptions of passing trains. It has been in progress two years and will require several years more to complete.

In laying the brick for the arch the only novelty is in the use of a portable platform on which the masons work, which can be raised or lowered as desired.

The tunnel is lit for its whole length by electric light; the total number of 30 c. p. Edison incandescent lamps used is 296.

The total cost of the Cascade tunnel to the Northern Pacific Railroad Company under Mr. BENNETT'S contract was $1,160,000, or $118 per lin. ft. By its completion the company secured a permanent route across the Cascade Mountains with maximum grades of 116 ft. per mile. The accompanying tables, taken from the original records, show the detailed cost to the contractor and to the railroad company of the work done on the tunnel during the month of November, 1887.

COST OF WORK DONE ON THE CASCADE TUNNEL DURING THE MONTH OF NOVEMBER, 1887.

COST OF WORK TO CONTRACTOR.

Labor	$22,897.75
Material	7,948.72
Miscellaneous	6,581.05
Cost per lin. ft. $74.56, or total	$37,427.52
Standard section, 504 lin. ft. @ $78	$39,312.00
Extra excavation, 1,683 cu. yds. @ $4.50	7,573.50
Timber lining, 160,000 ft. @ $35	5,600.00
Cost per lin. ft. $104.14 or total	$52,485.50
Contractor's profit, $29.87 per lin. ft., or total	$15,057.98

NOTES.

Progress.—East end 246 ft.; west end, 258 ft.; total, 504 ft.; daily average, 16.8 ft.

Timber.—Lining was required for the entire length excavated in November.

Rock.—Was of same general nature as portion of tunnel already excavated, a soft basaltic, which drills well, but disintegrates rapidly on exposure.

General.—There are no doubt discrepancies in this statement, but the totals are believed to be substantially correct. The month of November was favorable in every respect for the contractor, excellent progress was made (the best since work was begun) and there were no accidents or other interruptions to the work.

EAST END.

Labor.		
Superintendent, ½ mo., @ $500	$250.00	
" 1 " @ $175	175.00	
Master mechanic, ½ " @ $150	75.00	
Engineers, 4 × 30 = 120 days @ $4	480.00	
Machine repairers, 3 × 30 = 90 dys @ $3.50	315.00	
Firemen, 2 × 30 = 60 " @ $2.50	150.00	
Blacksmiths, 3 × 30 = 90 " @ $4	360.00	
" helpers, 3 × 30 = 90 " @ $2.50	225.00	
Carpenters, 354 days @ $4	1,062.00	
Foremen, 16 " @ $4.50 (average)	720.00	
Drillmen, 293 " @ $4.50	1,625.50	
Chuckmen, 286 " @ $3.00	858.00	
Muckers, 1,097 " @ $2.75	3,013.75	
Nippers, 60 " @ $2.50	150.00	
Dumpmen, 60 " @ $2.50	150.00	
Car drivers, 60 " @ $2.50	150.00	
Timekeeper, 30 " @ $2.50	75.00	
Lampmen, 60 " @ $2.50	150.00	
Laborers, 550 " @ $2.50	1,375.00	
Bonus to employees for daily progress over 6 ft	300.00	
		$11,062.25
Material.		
82,000 ft. timber @ $10	820.00	
762 lbs. wrought iron @ .06	45.72	
62½ cords wood @ $3	187.50	
240 tons coal @ $4	960.00	
900 caps (estimated) @ .01	9.00	
14,400 ft. fuse " @ .01	144.00	
9,000 lbs. giant powder @ .16	1,440.00	
		$3,606.22
Miscellaneous.		
Assumed value of plant $50,000, 6% interest on same	250.00	
Depreciation of plant 75% on whole job, ⅓ of 75% of $50,000	1,339.28	
10% on all the above to cover all possible omissions	1,625.77	
		$3,215.06
246 ft. tunnel all timbered, therefore cost contractor $72.70 per ft., or total		$17,883.82
November estimate.		
246 ft. tunnel, standard section @ $78	$19,188 00	
821 cu. yds. extra excavation @ $4.50	3 694.50	
82,000 ft. timber lining @ $35	2,870.00	
246 ft. tunnel all timbered, therefore cost N. P. R. R. $104.68 per ft. or total		$25,752.50

WEST END.

Labor.		
Superintendent, ½ mo., @ $500	$250.00	
" 1 " @ $250	250.00	
Master mechanic, ½ mo., @ $150	75.00	
Engineers, 4 × 30 = 120 days @ $4	480.00	
Machine repairers, 3 × 30 = 90 dys @ $3.50	315.00	
Firemen, 4 × 30 = 120 " @ $2.50	300.00	
Blacksmiths, 2 × 30 = 60 " @ $4	240.00	
" helpers, 2 × 30 = 60 " @ $2.50	150.00	
Carpenters, 396 days @ $3	1,188.00	
Foremen, 160 " @ $4.50 (average)	720.00	
Drillmen, 294 " @ $3.50	1,029.00	
Chuckmen, 293 " @ $3 00	579.00	
Muckers, 1,138 " @ $2.75	3,129.50	
Nippers, 60 " @ $2.50	150.00	
Dumpmen, 60 " @ $2.50	150.00	
Car drivers, 60 " @ $2.50	150.00	
Timekeeper, 30 " @ $2.50	75.00	
Lampmen, 60 " @ $2.50	150.00	
Laborers, 602 " @ $2.50	1,655.00	
Bonus to employees for daily progress over 6 ft	500 00	
		$11,835.50
Material.		
78,000 ft. B. M. timber @ $10	780.00	
800 lbs. wrought iron @ .06	48.00	
61½ cords wood @ $3	193.50	
240 tons coal @ $4	960.00	
900 caps (estimated) @ .01	9.00	
14,400 ft. fuse " @ .01	144.00	
13,800 lbs. giant powder @ .16	2,208.00	
		$4,342.50
Miscellaneous.		
Assumed value of plant $50,000, 6% interest on same	250.00	
Depreciation of plant 75% on whole job, ⅓ of 75% of $50,000	1,339.28	
10% on all the above to cover all possible omissions	1,776.72	
		$3,366 00
258 ft. tunnel all timbered, therefore cost contractor $75.75 per ft. or total		$19,544.00
November estimate.		
258 ft. tunnel, standard section, @ $78	$20,124.00	
862 cu. yds. extra excavation @ $4.50	3,879.00	
78,000 ft. timber lining @ $35	2,730.00	
258 ft. tunnel all timbered, therefore cost N. P. R. R. $103.62 per ft. or total		$26,733.00

The Government Timber Tests.

In reply to many inquiries regarding the comprehensive timber tests inaugurated in the Forestry Division of the Department of Agriculture, a circular has been issued giving the following brief statements regarding the objects and methods of the work. Mr. B. E. FERNOW is Chief of the Division. The tests were described in our issue of Aug. 8.

It will be admitted by all who have to handle wood in building, engineering and manufacturing, that our knowledge regarding the properties of our various timbers is not very satisfactory, and that while attempts more or less systematic have been made to determine these properties, and knowledge gained from experience exists among those who have handled certain classes of wood for certain purposes, there does not exist much reliable published information for general use. The reason for this deficiency may be explained from the fact that wood, being a non homogeneous material, varies very largely in its qualities. Not only does there exist a wide range of qualities in the same species if grown under different conditions, but the quality varies in the same tree from the butt to the top and from the heart to the bark. To arrive then at any satisfactory results in an experimental determination of the properties of wood, it is necessary to derive them from the test material of known origin, and furthermore, to establish any laws which will be generally applicable in referring quality to physical appearance, structure and origin of material, it is necessary to examine and test carefully a large number of specimens. The difficulty for private enterprise to secure the test material in sufficient quantity and with a full knowledge of its origin, in fact the magnitude of an investigation of this kind, renders it pre-eminently an undertaking for a government agency. This has also been recognized by the Prussian government, but the U. S. Department of Agriculture can boast of having inaugurated such elaborate work one year earlier.

Besides more reliable data regarding the properties of our principal timbers, there is to be gained from this investigation a means of determining quality by the examination of physical appearance and structure, and of establishing an inter-relation between quality and conditions of growth. To define the objects of the work more in detail, some of the questions which it is expected ultimately to solve may be formulated as follows:

What are the essential working properties of our various woods and by what circumstances are they influenced? What influence does seasoning of different degree have upon quality? How does age, rapidity of growth, time of felling and after-treatment change quality in different timbers? In what relation does structure stand to quality? How far is weight a criterion of strength? What macroscopic or microscopic aids can be devised for determining quality from physical examination? What difference is there in wood of different parts

of the tree? How far do climatic and soil conditions influence quality? In what respect does tapping for turpentine affect quality of pine timber?

It is also proposed to test, as opportunity is afforded, the influence of continued service upon the strength of structural material, as for instance of members in bridge construction of known length of service. This series of tests will give more definite information for the use of inspectors of structures.

Besides these problems many others will arise and be solved as the work progresses, and altogether a wealth of new knowledge regarding one of our most useful materials must result. It is proposed to publish results from time to time.

The collection of the test material is done by experts (Dr. CHARLES MOHR, of Mobile, Ala., for Southern timbers). The trees of each species are taken from a number of localities of different soil and climatic conditions. From each site 5 trees of each species are cut up into logs and disks, each piece being carefully marked so as to indicate exactly its position in the tree; four trees are chosen as representative of the average growth, the fifth or "check tree" the best developed specimen of the site. Disks of a few young trees, as well as of limbwood, are also collected for biological study. The disk pieces are 8 ins. in height and contain the heart and sapwood of the tree from the north to the south side of the periphery. From 50 to 70 disk pieces and from 10 to 15 logs are thus collected for each species and site. A full account of the conditions of soil, climate, aspect, measurements and determinable history of tree and forest growth in general accompanies the collection from each site. The disks are sent, wrapped in heavy paper, to the Botanical Laboratory of the University of Michigan, at Ann Arbor (Mr. F. ROTH, in charge), to be studied as to their physical properties, their macroscopic and microscopic structure, rate of growth, etc. Here are determined (*a*) the specific weight by a hygrometri cmethod; (*b*) the amount of water and the rate of its loss by drying in relation to shrinkage; (*c*) the structural differences of the different pieces, especially as to the distribution of spring and summer wood, strong and weak cells, open vessels, medullary rays, etc.; (*d*) the rate of growth, and other biological facts which may lead to the finding of relation between physical appearance, conditions of growth and mechanical properties. The material thus studied is preserved for examinations and tests as may appear desirable, the history of each piece being fully known and recorded.

The logs are shipped to the St. Louis test laboratory, in charge of Prof. J. B. JOHNSON. They are stenciled off for sawing and each stick marked with dies, corresponding to sketch in the record, so as to be perfectly identified as to number of tree, and thereby its origin, and as to position in tree. After sawing to size, the test pieces are stacked to await the testing. Half of every log will be tested green, the other half after thorough seasoning. A determination is made at the time of testing of the amount of water present in the test piece, since this appears greatly to influence results. From each tree there are cut two or three logs, from each log three or four sticks, two of standard size, the other one or two of larger size. Each standard stick is cut in two, and one end reserved for testing two years later after seasoning. The standard size for the sticks is 4×4 ins. and 60 ins. long for cross-breaking tests. There will, however, be made a special series of cross-breaking tests on a specially constructed beam testing machine, gauged to the Watertown testing machine, in which the full log length is utilized with a cross-section of 6×12 up to 8×16 ins., in order to establish the comparative value of beam tests to those on the small test pieces. It is expected that on the average 50 tests will be made on each tree, besides 4 or 5 beam tests, or 250 tests for each species and site. All due caution will be exercised to perfect and insure the accuracy of methods, and besides the records which are made directly in ink into permanent books, avoiding mistakes in copying, a series of photographs, exhibiting the character of the rupture, will assist in the ultimate study of the material, which is also preserved.

Such work as this, if done as indicated, and well done, will never need to be done over again. The results will become standard the world over. The strength and value of a given species or even stick will no longer be a matter of opinion, but a question of established fact, and we will learn not only to apply our timbers to the use to which they are best adapted, but also what conditions produce required qualities, thus directing the consumer of present supplies and the forest grower of the future. The American Association for the Advancement of Science, in its Section of Mechanics and Engineering, has created an Advisory Board to assist in securing improved methods, and the co-operation of other authorities will be welcomed to make this a truly national work. So far the work has been confined to Southern pines and oaks, the scant appropriations available, and other unfavorable conditions, making such limitation necessary. The work will be extended and its progress pushed in proportion to appropriations made by Congress, which depend upon the interest which the work may arouse among those to be benefited by it.

The Comparative Merits of Various Systems of Car Lighting.

XI.

(*Continued from page 291.*)

OIL-BURNING LAMPS.

The improvement in household lamps burning ordinary kerosene which has taken place during the past score of years is a matter with which everyone is familiar. Similar improvements have been made during that time in the lamps used for car-lighting. The contrast between the smoky, ill smelling kerosene lamp, which was the main reliance for household illumination a score of years ago, and the modern central draft lamps giving a light of 30 or 40 candle power is no greater than the contrast between the old-fashioned car-lamp and the best types of car-lamps now in use.

Lamp Burners.—The ordinary mineral oil lamp of both the oldest and the most modern styles consists of a reservoir of oil; into which dips a fibrous wick. This passes outward from the reservoir, through a closely fitting passage called a wick tube.

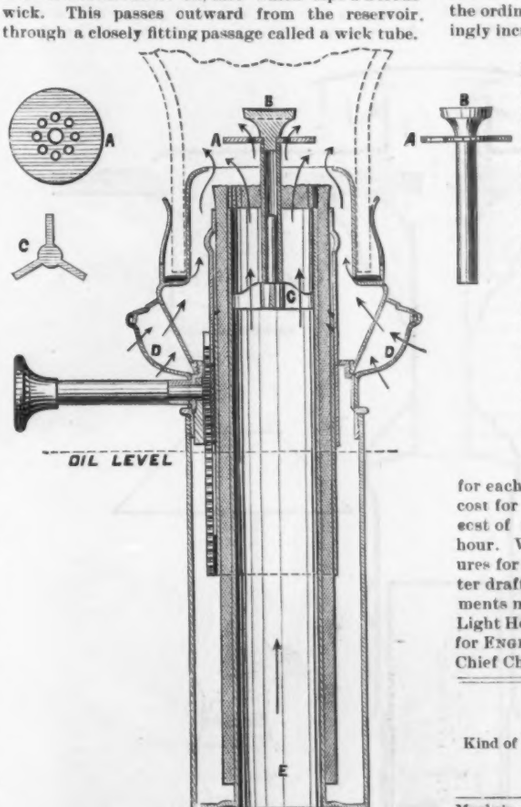


Fig. 1. Vertical Section of Belgian Lamp Burner.

The oil is drawn up through the wick by a capillary attraction and burns at the top of the wick tube. The flame is made bright and smoke is prevented by directing a current of air against its surface. This is done by placing metal deflecting surfaces adjacent to the flame and producing draft by means of a glass chimney.

The above description applies to practically all lamps burning mineral oil: and the manner in which the most perfect modern lamp burner differs from the old fashioned burner with its dim light is first in the means for supplying air to the surface of the flame, second in the means for heating the air before it reaches the flame, and third in the means used to facilitate the flow of oil from the reservoir to the flame.

One of the very first improvements over the plain flat wick burner was the familiar Argand burner, in which the wick tube and wick are annular in cross section instead of rectangular. This had the advantage of giving a strong draft and a hotter and brighter flame. Another improvement which found especial favor for car lamps was the duplex or dual burner, in which two flat wick tubes are placed side by side and the flames from them unite to form a single flame. The reason why this has been especially popular for car lamps is that with 300° oil, which is less fluid than ordinary kerosene, the lamp more frequently grows dim from the sluggish flow of the oil than from lack of air supply. The dual burner gives a double supply of oil to a single flame, while its increased heat also helps the draft and the air supply.

But the greatest improvement over the old styles of mineral oil burners has been made in the invention of the central draft burners. These are similiar to the old-fashioned argand burners, in that the wick tube is of annular cross-section; but they have the additional important feature of a "flame spreader" or device for deflecting the upward air current through the central tube against the surface of the flame.

In most of the central draft burners a current of air is also directed against the outside of the flame, either by a brass deflector or by a corrugation of the chimney. The result of this "forced draft" on both sides of the flame is to greatly increase its temperature and brilliancy. It becomes much whiter than the ordinary kerosene flame, and gives a correspondingly increased light.

Some manufacturers of these improved lamps claim that for a given consumption of oil nearly double the amount of light is given out by the best types of center draft lamps compared with the ordinary duplex burners. Careful experiments, however, do not indicate such a gain. Experiments were made in the Chicago, Milwaukee & St. Paul laboratory, and reported by Mr. GEO. GIBBS, Mechanical Engineer, in a paper before the Western Railway Club last spring (see ENGINEERING NEWS, March 14, 1891) to determine the relative efficiency of several different types of burners. Those tested were the Moehring Argand burner (see "Car Builders' Dictionary," p. E 205, Fig. 872), the ordinary duplex burner, and the Acme, a center draft burner made by Adams & Westlake. The following table shows for each the total candle power in the car, the total cost for oil per hour (at 9 1-5 cts. per gall.), and the cost of the oil burned in cents per candle power hour. We have added to the latter column the figures for the Belgian burner, another improved center draft lamp, taken from the report of experiments make by Major D. P. HEAP, U. S. A., for the Light House Board, and from the experiments made for ENGINEERING NEWS by Mr. W. D. B. PENNIMAN, Chief Chemist, B. & O. R. R.

Kind of burner.	Maker of test.	Number of burners in car.	Total candle power in car.	Cost of oil burned per hour. Cts.	Cost of oil per candle power hr. Cts.
Moehring	Gibbs	13	196	1.67	0.00107
Duplex	Gibbs	13	130½	1.21	0.00088
Acme	Gibbs	7	168	1.94	0.00116
Belgian	Heap.	.....	.....	.....	0.00095
Belgian	Penniman	.....	.....	.....	0.00083

From the above table it appears that the central draft burners do not produce much, if any, more light from a given amount of oil than the old Moehring and duplex burners. But though honors are easy in this respect, the central draft burners have a decided advantage in the increased amount of light given out by a single lamp, in their greater freedom from smoking and in the smaller cost of keeping them in order.

On the other hand, it should be said that some of the central draft burners produce so intense a heat as to whiten the glass chimney; and if pains is not taken to guard against it they may also overheat the oil reservoir.

Desirable Qualities in a Car Lamp.—In many respects, of course, the requirements of a lamp for car lighting are the same as those for household lighting; but there are other respects in which the requirements differ.

One important requirement in a household lamp is that it shall not give off a disagreeable odor. The products of combustion of car lamps, however, are generally carried off to the outer air by a ventilating flue over the lamps, so that this requirement is not

important here. In almost every other respect however, the requirements of car service are much more exacting than those of household service. The light should not flare, no matter at what rate the car is moving or the wind is blowing, and notwithstanding the drafts that may enter the car through doors, windows or ventilators. The wicks must not jar down with the motion of the car. The lamp tube should be warmed by the blaze enough to facilitate the flow of the heavy oil used in car lamps, yet not enough to heat it anywhere near the point of vaporization. The preferable arrangement of the oil reservoir is on the student lamp principle, so that the oil will be fed by the wick from a constant level. The reservoir should be conveniently removable for filling, but when placed in position it should be securely held in place, and the fastening of lamp, reservoir, or any other removable part should be such as to make it impossible for careless employees to leave lamp or reservoir in an insecure position. Drip from the lamps should be guarded against, for the sake of saving carpets and clothing. Removable glass drip cups effect this admirably. Finally the lamp and its supports should be designed with good taste, yet with such a finish that they may be easily kept clean and bright, for the labor of caring for the lamps is a principal item of expense in oil lighting systems.

Various Styles of Lamps.—That the center-draft lamp not only gives a great volume of light but meets to a good degree the other requirements of car lighting service, seems pretty well proved by the experience of Adams & Westlake, of Chicago, one of the principal firms manufacturing car lamps. They began offering the Acme center draft burner to their customers in 1888; and although the cost of lamps fitted with it is about 20% more than when fitted with duplex burners, we understand that nine-tenths of their orders at present are for lamps fitted with Acme burners. Of this lamp the makers say:

Tested photometrically the Acme burner shows a light many candle power greater than the popular Moehring, Argand or the dual burners which have been heretofore conceded to be the best. The wick is adjusted by a thumb-wheel and ratchet. There is no tying of the wick with thread to keep it in place. There is no cone to the burner, hence no part of the flame is hidden from view and no light is wasted. Its combustion is perfect and the flame is steady, clear and strong.

A style of burner very similar to the Acme is made by the Dayton Mfg. Co., Dayton, O. The manufacturers inform us that this burner when tested to its utmost capacity gives a light of 68 c. p. From actual experiments with lamps in use on cars they have found that each burner will average 38 candle power. To remove this lamp from its supports for filling or cleaning, the chimneys are removed and the lamps and reservoir are turned half way around, when they can be readily removed from the lamp-holder with no danger of breaking the shades.

Another central draft lamp is made by Jas. L. Howard & Co., of Hartford, Conn., and is described as follows:

The oil is held at a uniform level, near enough to the flames to prevent charring of the wick, while overflow is prevented by independent reservoirs to each burner. The construction of the burners allows the regular $1\frac{1}{4} \times 6$ in. round wicks to be as easily put in as those in the ordinary flat wick burners, and a special friction device prevents their being jarred down by any motion of the car. The oil capacity is so proportioned that they will burn at 50 candle power for 12 hours, or for a longer time if the flame is not carried quite as high.

A "Safety" dome is permanently fixed to the center ring to receive the detachable fount, preventing the possibility of displacing the fount in case of accident. The smoke bells and outside jacks protect the roof from heat by giving free circulation of air between the wood work and the lamp ventilator pipes.

The chimney springs are so made as to prevent their overheating and loss of temper and the oil is fed to the burners on the student lamp principle.

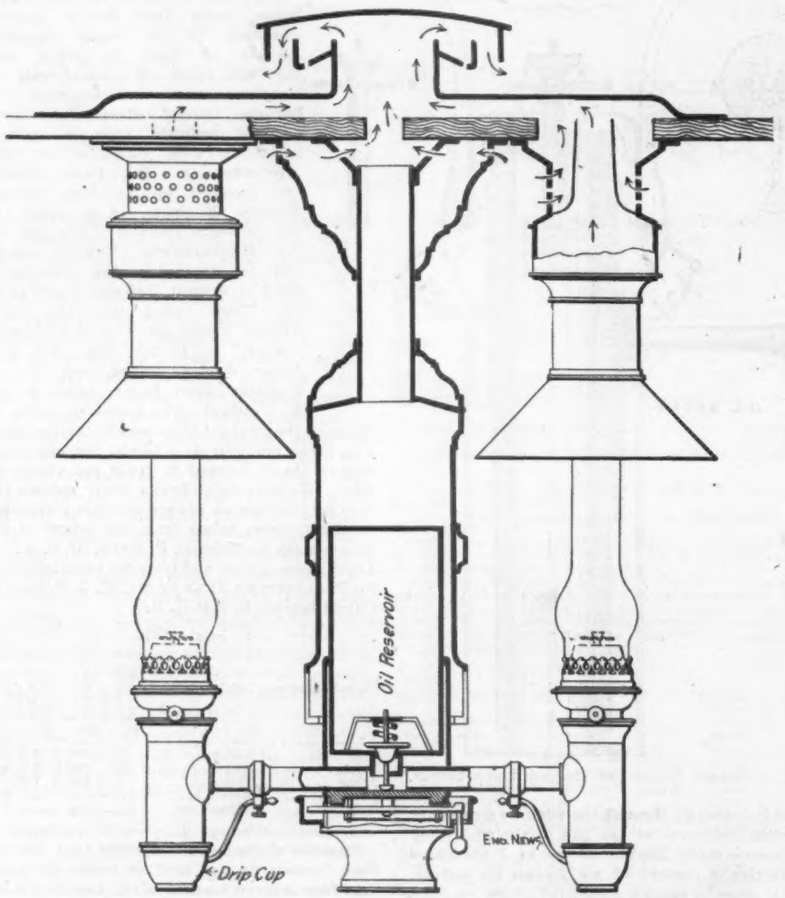


FIG. 2. WESTLAKE'S IMPROVED VENTILATING CAR LAMP, WITH BELGIAN BURNER.

A lamp for car lighting has been recently designed by Mr. WM. WESTLAKE, who was one of the founders of and was for many years connected with the firm of Adams & Westlake, of Chicago; and though the lamp is not yet in practical use on cars, Mr. WESTLAKE's long experience in the design and construction of lamps and his strong belief in this as one of the most meritorious of his designs we believe to be sufficient to warrant its illustration and description here. Coupled with this is the fact that the Belgian burner which Mr. WESTLAKE has adopted for this lamp, showed in the tests by Mr. W. B. D. PENNIMAN, the greatest candle power and the smallest oil consumption for a given amount of light of any oil lamp tested. The list of lamps tested included (with two or three exceptions which we are glad to allow for, lest this statement should seem too sweeping) all the prominent makes of oil lamps for car lighting. The photometric tests of the Belgian lamp we shall describe at length in a following number; but we may say now that it showed an excellent distribution of light as well as high candle power.

As for the degree to which this lamp and burner would fulfil the other requirements of car lighting service our readers must judge for themselves from the following description. Mr. PENNIMAN'S tests were for candle power and oil consumption alone.

The Belgian Burner.—This burner was designed by two Belgian inventors. In its general features it is similar to other central draft lamps. Fig. 1 shows a vertical section of the burner. Its chief peculiarities are, first, the arrangements for securing a copious flow of oil through the wick, and, second, the peculiar construction of the flame spreader. The wick is woven in cylindrical shape, with an outer and an inner layer, loosely connected, which tends to increase its capillarity. It encircles a fixed central tube, and is moved up or down by an outer tube to which it is attached by projecting barbs. Thus compression of the wick at any point is avoided. To further facilitate the flow of oil this wick carrying tube is made as an open framework, and has shallow corrugations on its inner surface next the wick.

This wick carrying tube has a rack on one side engaging with a pinion, by which the height of the wick is adjusted. This mode of moving the wick prevents the raising of one side more than another.

The direction of the air currents in the Belgian burner is shown by arrows. It will be seen that the flame spreader is made in two parts, the lower one, a flat disk, the upper, a cone shaped deflector. The disk is pierced by a series of small holes, and the air rising through them is heated and deflected by the cone, and strikes the surface of the flame near its top where smoking and imperfect combustion are most likely to occur.

While this burner has not yet been used in regular service on car lamps, it is among the most popular of central draft burners for household lamps and received the first prize, a gold medal, at the Paris Exposition of 1889. The manufacturers (the Belgian Lamp Co., 31 Barclay St., New York) claim sales of over 600,000 lamps per annum.

The Westlake Lamp.—Fig. 2 shows in elevation and partial section the car lamp designed by Mr. WM. WESTLAKE, referred to above, it will be seen that there is no open space between the top of the chimney and the head lining. The shade is attached to a metal ventilator extending upward to the head lining and connecting with a ventilating jack on the car roof. Thus all heat and products of combustion are carried out of the car, and in addition a considerable amount of ventilation is produced by the current of air induced by the heat of the lamp.

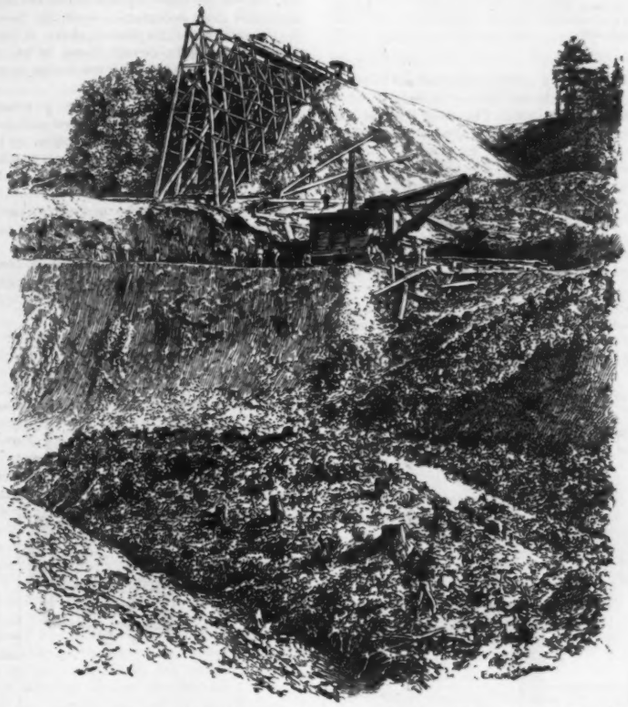
The lamp may be lighted without removing the chimney by thrusting a gaslighter up the central tube. The drip cups are made to swing to one side to facilitate lighting the lamps as well as cleaning the cups.

The construction of the oil reservoir and the lamp supports is evident from the drawing. It will be seen that the reservoir is surrounded by an air space, and there is a free passage for the heated air with any odor arising from the oil to the ventilating opening at the top of the central suspending tube. These three openings in the car roof are covered by a single ventilating jack on the outside, as shown by the drawing.

The subjects of relative cost, safety and photometric power of oil lighting we shall take up later, discussing it in connection with the other systems of car lighting with which it competes.

A Heavy Earth Embankment.

The illustrations here given are from photographs of an embankment now under process of construction on the Lehigh Valley Ry. The extreme height of the embankment is 154 ft. and the distance across the valley on the grade line is 1,100 ft. The approximate quantity of material required is 750,000 cu. yds. The arched culvert at the bottom of the fill has a span of 20 ft. and is 375 ft. long in the barrel and 471 ft. long including the wings. The depth of the sheeting on this arch is 48 ins. at the springing line and 36 ins. at the crown. This work is being performed by the well-known contracting firm of CHARLES MCFADDEN & SONS.



View Along Embankment, Lehigh Valley R. R., Showing Manner of Making Fill.

View Across Embankment, Lehigh Valley R. R., Showing Culvert.

The Utilization of Anthracite Waste by Gasification in Producers.*

That the problem of utilizing anthracite waste is worthy of the thought bestowed upon it may be shown in few words. In the year 1889, for instance, 35,408,000 tons of coal were sent to market from the anthracite regions of Pennsylvania. According to the report of the State Geological Survey, the amount of coal thrown on the dumps as waste varies, with circumstances, from 44 to 60% of that shipped to market. The smaller of these figures represents 16,579,000 tons of waste for that year; and it is obvious that if this or any considerable portion of it could have been saved, it would have constituted an important addition to the fuel supply of the country. It is not surprising, therefore, that so much attention has been given to the utilization of this waste.

Among the many lines of experiment pursued with this object in view, the conversion of the carbon of the culm into producer-gas seems at first to promise the most satisfactory solution of the problem. It is well known that in foreign producer-plants almost all kinds of combustible waste are converted into gas. Especially on the continent of Europe it is not uncommon to find gas made from turf or peat containing a large percentage of water, or from wet sawdust, shavings, or green slabs just from the saw mill, and successfully applied to high temperature work.

Our costly labor and cheap coal hardly warrant (except in peculiar cases) our going to such sources for fuel, but the demonstrated practicability of so doing makes it natural to infer that the finely divided and impure state of anthracite culm would not prevent it from being a suitable material for making gas, while its higher percentage of carbon would, in the absence of special technical disadvantages, make it economically superior.

In the old days of the natural-draft producers, only the large sizes of anthracite were used, and the fuel-bed was kept of a proper thickness to insure an even distribution of the air currents. When a forced blast came into use the general opinion was that the problem of burning fine anthracite had been solved, and that it would be necessary only to increase the pressure of the blast in proportion to the fineness of the coal. Advocates of this method pointed to the blast-furnace as a proof of the correctness of their theory, forgetting that the conditions of working were quite different in the two cases, and that the successful use of blast at high pressure in the former by no means proved its practicability in the former.

Some time ago the writer was interested in a series of experiments extending over several months, with the Taylor gas producer, which were conducted with the view both of perfecting the details of the apparatus and of determining the suitability of various fuels for making producer-gas, and the best treatmdnt of them in the producer.

The Taylor producer was chosen for this latter work, both on account of its being free from the defects of most producers, and because its design seemed to be specially adapted to the gasification of fine anthracite. A solid circular plate taking the place of the ordinary grate, and the fuel being supported on a deep bed of ashes, the fire can be cleaned with equal ease, without regard to the fineness of the fuel.

But the insurmountable difficulty is the action of the fine particles of fuel in obstructing the passage of the air through the fuel-bed. In the gasification of bituminous coal, the size of the coal makes little or no difference, as its coking keeps the fuel-bed open. But in the case of anthracite and other non-coking coals, the degree of permissible fineness is limited by the tendency of the air-blast to choose the easiest line of travel; and when the fineness of the coal is increased beyond a certain point, this line will invariably be next the walls of the producer. The result is, that while the main body of fuel remains comparatively dead, combustion next the walls is very active, and the passage of the gases is so rapid that the carbonic acid formed by the first combustion of the coal has no time to be reduced to carbonic oxide. Thus, the gas produced is both small in amount and very poor in quality. Moreover, serious clinkers are formed by the high temperature, and the producer soon becomes choked.

By reducing both the depth of the fuel and the pressure of the blast, this irregular distribution of the air can be corrected; but to make this remedy effective when the finest anthracite is used, the rate of combustion must be reduced to a point where the corresponding increase in the size of the plant required makes its cost prohibitory.

Experience shows that the sizes known to the trade as "No. 1 Buckwheat" and "Pea" are best suited for use in a producer with forced blast. For in these sizes the proportion between the interstices and the solid particles is such that a fuel-bed of sufficient height to make a gas low in carbonic acid can be carried, without causing irregularities in combustion, under a blast-pressure sufficient to insure a satisfactory rate of gas-making.

Especially in the older culm heaps there are considerable quantities of buckwheat or even larger sized coal which could, doubtless, be recovered by washing and screening; but the profitableness of this is doubtful, and depends upon local circumstances.

Fine anthracite can be used in considerable quantities in a producer, when it is mixed with sufficient coking bituminous coal to keep the fuel bed open; but it is usually cheaper to use buckwheat or pea alone, the excessive cost of the soft coal in the anthracite regions more than counterbalancing the low price of the dust. Moreover, the mixture works only indifferently well.

Where freight charges constitute an important proportion of the cost of the fuels, the large percentage of ash in the culm would make its economy very doubtful in comparison with well-prepared buckwheat, even were no difficulties encountered in its gasification. A series of experiments, conducted by the writer, in firing boilers with the two kinds of fuel, clearly showed this to be the case where the two sizes were used on grates capable of handling both equally well.

Both fuels being used under the same boiler, and the water evaporated being carefully weighed, the opportunity for comparison was a satisfactory one, and the conclusions were definitely in favor of the economy of the larger-sized and purer fuel.

Although invention has successfully overcome the difficulties of gasifying the smaller sizes of prepared anthracite, and such gas is used in a variety of industries in both high and low temperature work with entire satisfaction, it seems clear that we are as far as ever from the utilization of the refuse in this way. The most that can be done is to reduce the amount of refuse as far as possible by a more thorough separation of the buckwheat from the culm; looking to other processes for the final utilization of the remaining carbon.

* A Paper by W. H. BLAUVELT, Philadelphia, Pa., read at the Glen Summit meeting of the American Institute of Mining Engineers.

Electricity in Mining, as Applied by the Aspen Mining and Smelting Company.*

The Aspen Mining and Smelting Co., of Aspen, Pitkin Co., Colo., was the first mining company in America to employ electrical power for hoisting. Early in the year 1888 the question of power for the development of the ore-horizon lying below the level of the tunnel through which the property is worked, became one of importance. The conditions under which it was proposed to use power were as follows (See Fig. 1): The company's mines lie upon the northwestern slope of a mountain, the ascent of which is

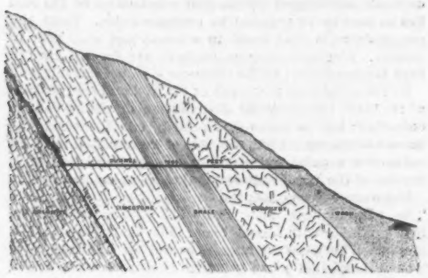


Fig. 1.

at an angle of 28° from the horizon. The ore, consisting of argentiferous galena and other silver bearing mineral, is found at or near the plane of contact of a superincumbent mass of blue limestone, with an underlying bed of dolomite. This contact plane dips north 30° west, at an angle of 45° with the horizon.

A tunnel 1,000 ft. in length, driven south into the mountain near its base, penetrates this ore-mass at a vertical depth of nearly 500 ft., and through this the ore and the waste material are brought to the surface. For the purposes of drainage and transportation, the tunnel has received a grade of 3% toward its mouth, while from its breast or inner extremity level branches or drifts are run both to the right and left, following the strike of the ore-bearing plane, and developing it in its lateral extent. The development below the tunnel level was begun by sinking two inclines, which were intended to follow the ore-plane in its descent, and which, it was contemplated, might acquire considerable depth. One of these inclines began near the inner extremity of the tunnel, and the other was started 300 ft. distant in the drift toward the north. Both descended below the tunnel level at an angle of 60°. Power, applied to hoisting machinery of some kind, was necessary to bring up the ore and waste material from these inclines, and from the levels that would be driven in future.

The first plan considered was the use of steam power; that of compressed air was then discussed. Both of these plans were finally laid aside for weighty reasons, although the latter offered several advantages over the use of steam in the inside workings. It then occurred to Mr. FRED G. BULKLEY, the manager of the company, to duplicate the operations of the Compagnie de la Ferronière, on a larger scale; to use electrical power, utilizing, for the generation of the current, the power daily going to waste through the channels of mountain streams in the vicinity. Accordingly a flume was constructed, with ample capacity, giving an effective head of 63 ft., and a 5-ft. Pelton water-wheel, was selected as the motor. A 50-HP., 500-volt, constant potential Edison dynamo was then set up and run under the direction of the Roaring Fork Electric Light and Power Co. This machine generated the current at a distance of 6,000 ft. from the mouth of the tunnel.

After long delays and by constant importunity, attended with more than one failure, Mr. BULKLEY finally secured the attention and aid of a manufacturer of electrical machinery, to provide the hoisting-plant for the mine, and finally, in July, 1888, the first electric-hoister used in mining work in America was placed at the head of the Veteran Tunnel, and successfully used for hoisting from the incline near this point. The same motor, by engaging with a second drum, draws the empty cars in the tunnel by a tail rope system, the loaded train running out by gravity. This hoist consists of a 7½ HP. street car motor, manufactured by the Sprague Electric Railway and Motor Co. This motor proved the success of the plant from the start, notwithstanding the trying conditions under which it was at first used—one of which was the great amount of moisture in the workings, which condensed upon the machine. Later, the iron pinions on the armature shaft were exchanged for raw hide pinions, diminishing the noise when running, and also the liability of any leakage of current to the levers and other parts of the machinery. The working of this motor was so successful that during the same year a similar hoist was placed at the head of the incline 300 ft. to the northeast. Each of these hoists was designed to raise 250 tons 250 ft. up a 60° incline every 24 hours, estimating 16 hours of actual working time. Fig. 2 shows, in plan, the arrangement of the electric hoist.

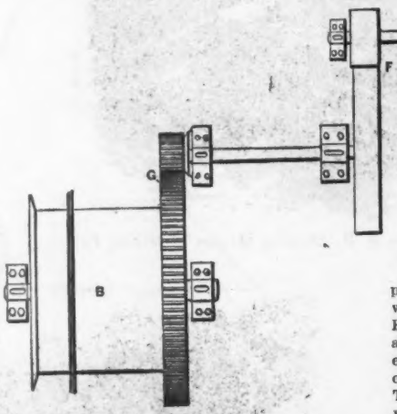
The first motor has been in constant use for hoisting for 3 years, during which time the cost of repairs has been as follows:

Replacing field magnet coils	$43.00
Rewinding one armature	80.00
Replacing commutators	75.00
Total repairs	$198.00

This does not include the cost of commutator brushes which have to be replaced from time to time—which is, however, a small item. The first item of expense above given was necessitated by the burning out of the insulation on the wires of the magnet-coils, which might have resulted from [illegible] or more of several causes. The second item was due to the bursting of the binding wires on the armature. This, having been anticipated, might have been guarded against. The last item, caused by the wearing out of the commutators, was due to the natural wear between the commutator and the copper brushes which were originally employed.

Recently the company has put carbon brushes upon all of the motors, and also uses them upon the dynamos. Since this change has been made, the motors have run without sparking, and the wear upon the commutators is inappreciable.

The company has an extra armature that can be used in either motor hoist, so that in case of accident very little time need be lost in repairing the damage. In the case of the accident to the field magnet coils, mentioned above



the burnt coils were replaced without much delay by others bought in Aspen. The total time lost, due to accidents or repairs, during the time the hoist has been in use amounts to 12 hours.

In the latter part of the year 1889 the company, having available water power not in use, decided to have its own generating plant. Previous to this it had been supplied with power from the Roaring Fork Electric Light and Power Co. Work was soon begun, and by July, 1890, the company was generating its own power. This plant has a capacity of 100 electrical HP., which is generated by two 50 HP. Thomson-Houston motor type dynamos, wound for a constant potential of 500 volts. These are run from 2 double Pelton water wheels, 42 ins. in diameter, *i. e.*, four 42-in. wheels, two being paired together on each shaft. Each of these 4 wheels is impelled by the force of the water issuing from 2 nozzles and applied to the wheels, as shown in Fig. 3.

A pressure of about 35 lbs. per sq. in., as indicated by a gage at the foot of the main column-pipe, is obtained from an effective fall of a little over 80 ft. This fall is obtained by fluming for a distance of 1,300 ft. The flume has a capacity of 1,000 cu. ft. of water per minute.

The requirements calling for greater or less power are met by deflecting the nozzles, which work on a ball and-socket joint, by means of a Woodward governor, set to maintain a constant speed of the water-wheel shaft from which it is actuated. The wheels are enclosed in an iron hood, 4 ft. by 4 ft., which can be taken off with little trouble, the joints being kept tight with rubber gaskets.

The adjoining ends of the water-wheel shafts carry a friction clutch, by means of which the shafts can be run as one shaft when it is desired to throw the output of both dynamos on one common line.

The electrical connections in the generating station are as simple as possible, the dynamos being connected with the switchboard by overhead wiring hung from the trusses.

Wiring.—The generating station is situated 6,000 ft. from the entrance to the tunnel. The stationary motors, now in use are situated at distances of 1,800 ft., 2,200 ft. and 1,000 ft. from the entrance underground. From the power station to the tunnel the current is carried by bare 00 copper wire, except for about 300 ft. at each end, where an underwriter's insulated wire of the same size is used. Inside the mine the current is carried to the two main hoisting stations at distances of 1,000 and 1,200 ft. by kerite seven-strand conductors, having a heavy insulation ⅛ in. in diameter. Okonite or Grimshaw insulated wires are used on all the other circuits inside the mine, where the insulation must necessarily be of the best. On none of the circuits inside the mine is there a loss exceeding 5%. Along the outside circuit there is at present, when the wires are carrying their maximum load, a loss of from 5% to 6%.

Cost of Generating.—The cost of generating, as obtained by dividing the cost of labor and lubricants (interest and depreciation are not included) by the horse power demanded, amounts at present to $0.00⅝ per H.P. per hour; and greater amounts of power could be furnished at a lower rate per horse power, as up to 100 H.P. no increase of plant would be necessary, the cost for labor would remain the same, and the cost of lubricants would advance but little.

In July, 1890, the company received from the Sullivan Diamond Prospecting Co., of Chicago, an electric diamond

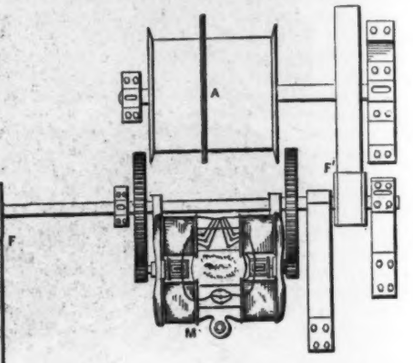


Fig. 2.

prospecting drill. This was the first drill of its kind, and was built for the company at the request of Mr. FRED. G. BULKLEY, with the understanding that it should have a thorough trial, and be retained if satisfactory. It is operated by a 3-HP. Thomson-Houston motor, and has a capacity of 400 ft., taking out a core 1⅛ in. in diameter. The drill was first set up on the surface, and experiments were made with it by drilling into an immense granite boulder. It was found that in this kind of rock it would drill 2 ins. per minute, taking out a core of the above diameter. It was then put in the mine, where it has been used steadily during the past twelve months for exploring the hanging and foot walls of the mineral deposit, which are respectively a hard blue and often silicified limestone, and a brown dolomitic limestone. In these rocks the machine drills at the rate of 1½ ins. to 2 ins. per minute; or in a shift of 8 hours, allowing for all delays essential to diamond drill work, the progress made varies from 6 ft. to 32 ft., depending upon the character of the rock. The average per shift, allowing for

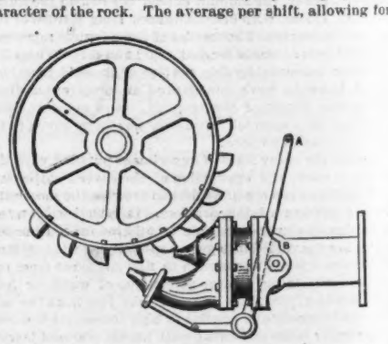


Fig. 3.

time lost in moving, setting up and drawing cores, is 15 ft., one drill man and one helper being employed. About 4,400 ft. have been drilled to date of writing, July 6, 1891. The exact cost, including all expenses, has been 68 cts. per ft. This is rather higher than was expected, and it is thought that it can be reduced.

Recently finding that the 7½ HP. hoist at the head of one of the inclines was getting too small for the work required, it was removed to another part of the mine where

*A paper by M. B. Holt, Aspen, Colorado, read at the Glen Summit meeting of the American Institute of Mining Engineers.

it could be advantageously employed, and a 25-HP. C. & C. electric motor put in its place. This larger motor is geared so as to raise a load of 3,000 lbs. up a 67° incline 275 ft. per minute. It is capable, by actual timing, of making the round trip from a depth of 550 ft., with a load of 3,000 lbs., in 3 minutes.

At the time of writing, the company is about to apply electrical power for running a small machine shop and its timber room and carpenter shop. It is also proposed in the near future to employ an electrical locomotive for surface tramming.

A contract has been made with the Thomson-Van Depoele Electric Mining Company by which this company is soon to receive, upon trial, a Thomson-Van Depoele electric percussion drill, and a motor transformer for supplying the drill with a current of 220 volts from our 500-volt mains.

The main working galleries of the mine are lighted by electricity, the current for which is taken from the power mains, and five 100-volt incandescent lamps are connected up in series. As the light produced is found to be sufficient, and the life of the lamp is thereby prolonged, six of these lamps are, in most cases, placed in series with each other. Eight HP. of electrical energy is now employed for lighting purposes.

The recognized advantages of electrical power for mining purposes may be briefly summarized as follows:

1. It can be transmitted long distances with small loss, thus making it possible to use power at such a distance from its source as would render it otherwise unavailable, as in the case before us.

2. The conductors for conveying electrical power from one point to another require less space, are more easily put in place and repaired, are easily tapped for branch circuits, and form a more flexible system throughout than any other mode of transmission permits.

3. The electrical system is ideal, viewed from the standpoint of cleanliness.

4. The stations for utilizing electrical power can be made to occupy a minimum space.

5. If this system does not assist ventilation, it does not on the other hand, vitiate the air in the mine workings.

After three years' use under the varying conditions of mining work, the electric current of 500 volts has proved itself free from danger to life, and has caused no inconvenience further than one or two severe shocks. Even the risk of receiving a shock has proved insufficient to suppress the spirit of investigation with which some men are endowed. The best illustration of the convenience and flexibility of the system is the diamond drill, where the conductors are unwound and strung up as the drill moves along, or taken down and coiled up, as may be desired.

The Norton Water-Tower of the Vyrnwy Aqueduct.

This water-tower, designed by Mr. GEORGE F. DEACON, M. Inst. C. E., and Engineer of the Liverpool water supply, is fully illustrated in the *Engineer*, of Sept. 18, 1891. It is chiefly remarkable for

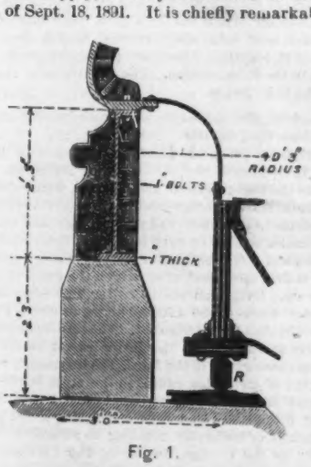


Fig. 1.

its size, which is 115 ft. in height and 82 ft. in outside diameter, with details simply worked out.

The base and support of the great tank is a tower of red sandstone masonry laid in Portland cement and of handsome design. The tank at top is the novel feature. This tank is 82 ft. in diameter with a center depth of about 30 ft. The bottom, 15 ft. 7 ins. deep, is an inverted dome of mild steel, plated and double-riveted. This dome is supported entirely upon the outside walls of the tower, having no center supports, and the basin is thus always in tension. An American design for a water tank with self-supporting hemispherical bottom was shown in our issue of Aug. 15.

The tendency to buckle in the circumference or rim is met by the compression member shown in our cuts, which also shows the general arrangement of this important part of the tank. This compression member is simply a great loop of riveted steel plates. The expansion and contraction of the tank is taken up by a complete ring of turned steel rollers, 12 ins. in diameter, and which for lightness are cheese-shaped in section instead of circular. These rollers rest upon a ring of heavy cast iron plates imbedded

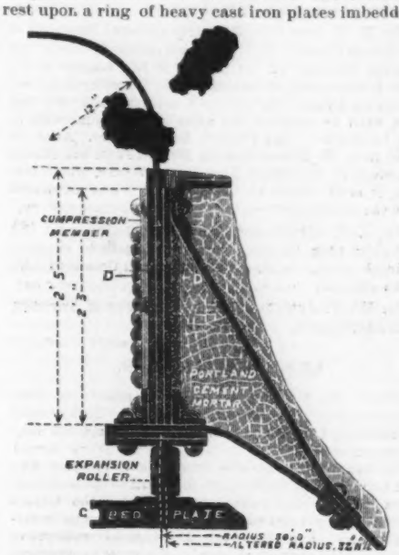


Fig. 2.

in Portland cement. The outside of the tank is faced with ornamental cast iron work, forming a coping to the tower.

As a further precaution against radial thrust against the masonry and the iron bed plates, a plough steel wire is passed around the outer circumference of the bed plate castings, in the groove shown in the cut. The connection between the cast iron sides and the tank is made by the use of comparatively light, bent plates of steel, which will yield sufficiently to allow for a difference of strain on the two materials.

The stand pipes, four in number, pass up in the middle of the bottom of the dome through stuffing boxes, and in no way support this dome. Access to the top of the tank is furnished by a stairway attached to the stand pipes and then passing to a vertical funnel through one edge of the tank. Especial care was taken with all the materials used. The stone had to withstand a crushing pressure of 350 tons per inch applied to a 4-in. cube; the steel for the compression member was required to have a minimum breaking strength of 32 tons, and a maximum of 36 tons per square inch on a length of 8 ins., and was required to increase in length 17% before fracture. The rest of the steel had to have a minimum breaking strength of 27 tons and a maximum of 31 tons per square inch with an elongation of 25% in an 8-in. length.

The Le Chatelier Pyrometer.

At the last meeting of the American Society of Mechanical Engineers there was considerable discussion over the best form of pyrometer, in which some reference was made to the Le Chatelier pyrometer as one of the most convenient and accurate. We abstract the following description of this ingenious instrument from an article by JOSEPH STRUTHERS in a recent number of the *School of Mines Quarterly*:

The principle upon which this pyrometer is constructed is that the current of electricity produced by heating a thermo-electric couple is proportional to the temperature to which it is heated. The thermo-electric couple consists of two wires, one of pure platinum and the other of platinum alloyed with 10% of rhodium, joined at one end. Conducting wires transmit the current from this couple to a convenient point outside the furnace, where it is measured by a galvanometer.

The wires of the couple are joined by soldering, by simple twisting or forging. Their thermo-electric properties are not altered by hammering and the couple can be heated for its entire length without producing the opposite electrical current caused by the heating of the solder or weld. These qualities make repairs easy in case of rupture.

In taking the temperature of an open-hearth furnace, the wires may be placed in an iron tube 10 or 12 ft. long with its end luted with clay, and the wires projecting an inch or more. The wires are exposed for only five seconds or so. Different methods are used for supporting the wires according to the nature of the furnace and number of observations to be taken.

The conducting wire is generally very long to permit the temperature of different furnaces of a plant to be taken without moving the galvanometer. It may be strung in any convenient location. The galvanometer used is a reflecting dead beat instrument which will distinctly indicate a current of 1-10,000,000 ampère.

The above is the apparatus employed for observations of scientific accuracy. For ordinary work a portable instrument is made which may be set up against any steady vertical wall 6 ft. square. The manipulation of the apparatus requires some care of course, but is within the reach of any one capable of making a fine reading.

The temperature is deduced from the current indications of the galvanometer by the use of a graphic chart made by using points produced by heating the couple to known temperatures, as the boiling point of mercury, the melting point of silver, &c., and constructing the extended scale from these points.

The accuracy of the portable form of the instrument is such that the indications are never more than 25 centigrade degrees in error, and considerably greater accuracy is obtainable with the fixed instrument.

Notes of a Vacation Trip from New York to Salt Lake City and Return.

The meeting of the recent "Irrigation Congress" in Salt Lake City formed a partial reason for visiting that far-away and notable city. Leaving New York at 6 p. m. on Thursday, Sept. 10, by the New York Central R. R. I arrived, via the Michigan Central, C. & N. W. and Union Pacific Railways at Salt Lake City about 2 a. m. Monday, Sept. 14, and I was agreeably surprised to find myself suffering but very little from fatigue after the long journey. All the railway lines traversed were in excellent condition, the trains made their schedule time, the dining cars were well stocked, and the daylight hours passed rapidly away in the agreeable companionship of old and intelligent travelers, and in observing the changing scenery from Niagara Falls, reached early Friday morning to the summit at Sherman, 8,247 ft. above sea level, and thence till nightfall found us in the vicinity of Ogden.

I had been warned by a Boston man that I would meet with very poor hotels in Salt Lake City. But it was a false prophecy, as, outside of Boston alone, there is not a hotel in all New England that will compare favorably with the "Knutsford," recently opened in the City of the Saints. The "Templeton," lately erected by the Mormon Church and conducted by a son of the late Brigham Young, is also a very large and finely furnished hotel, and visitors are urged to inspect it throughout, as the Mormons are exerting themselves to win the favor of the gentile tourists and commercial travelers. Salt Lake City is located on a fine plateau at the base of the Wasatch mountains, whose tall peaks, many of them snow-clad a goodly portion of the year, furnish a most interesting and grand landscape effect at all times; the River Jordan flows along the western boundary of the city, and the great Salt Lake is distant 18 miles. The city is laid out in ten-acre blocks, separated by streets 132 feet wide running, without exception, at right angles to each other. The block in which are located the Temple (begun in 1853 and still far from completion), the Tabernacle and the Endowment House, is the central point from which the streets are named by numbers toward the four points of the compass. The houses are mostly small and are still further dwarfed by the excessive width of the streets. However, a considerable number of large and very fine business structures have been erected, and the number is rapidly increasing. But the large blocks and wide streets create long intervening spaces and the stranger is constantly wondering why the new postoffice, or some other large building, has been located so far away from the business portion of the city. The streets are unpaved, and, except on the most frequented ones, vigorous crops of weeds have possession of

considerable proportion of the broad space. These weeds abound everywhere and are the outgrowth from the unkempt interior of the great unoccupied blocks. Brigham Young laid out his city for a community that was to subsist largely off the produce of the land, and "10 acres enough" was the ideal block.

Shade trees are not over plentiful and are mostly the cottonwood or other quick growers. Some handsome locusts are planted on finer residence streets, but they are exceptional.

Electric and cable railways occupy 22 ft. in the center of a great many streets, and furnish cheap and rapid transit to all important points in and near the city. Alongside of the sidewalks is a square board gutter 1 ft. wide by 8 ins. deep, through which water from the adjacent mountains runs continuously. The current on the main street is about four miles per hour; on other streets according to gradient. The water is for irrigation; householders have a specified hour when they can turn the water into their gardens; this is done by drawing a plug in the side of the ditch and diverting the water to the adjoining lot. Water is a precious commodity in these arid regions and none is allowed to be wasted. There are a few fine residences and well kept lawns in Salt Lake City, but the general appearance is one of dilapidation and untidiness. Real estate is in fair demand; the city is improving quietly in the business quarter, but it will be a long time before "Zion" can be made "beautiful" or desirable as a place of residence. If, however, the roadways can be narrowed by adopting broader sidewalks, and tree planting be more largely promoted to shelter pedestrians from the hot rays of a sun that is seldom obscured by clouds; if the present large blocks were subdivided by running 66 ft. streets through them in the business portion of the city, and concentration be adopted instead of diffusion, there would in time be a very desirable city where otherwise there will always be a huge, sprawling, ill-kept village. The great area to be watered, sewered and paved and maintained can only be done by excessive taxation of a community that would rather have their money than the improvements if they are to be bought at too dear a price. At present there are no sewers and no pavements, although there is a very fair water supply.

Two days at most are ample for sight-seeing. The Tabernacle is quite a remarkable structure. Its appearance is probably familiar to all our readers. To illustrate its acoustic properties the visitor is sent to the gallery 200 ft. distant from the railing by the pulpit platform. Conversation can be maintained in the softest of whispers. The noise occasioned by a common pin dropping only 2 inches onto the wooden railing is heard very distinctly. It would seem as if the noise of the congregation coming into the building would be annoying; but at a concert on the 16th, which I attended, there was nothing of this nature to be observed. I heard the great organ in four very fine renderings of choice music on the 15th, and then again in accompaniments on the evening of the 16th. It is undoubtedly a fine instrument, especially considering the circumstances of its home manufacture. The great Temple is closed strictly against visitors. The homes of the family of the late Brigham Young are too insignificant for notice. The "Amelia Palace," built for the favorite wife, and which was a most potent factor in the downfall of Mormonism, is but an ordinary wooden three story villa, rather freely ornamented like a Mississippi River steamboat. The only other notable attraction is the Great Salt Lake. A ride of 45 minutes by U. P. Ry. brings one to Garfield Beach, where there is a pier built out into the lake a few hundreds of feet and covered by the usual ornamental house. The bathhouses, all owned by the railway company, number nearly a thousand and are probably the largest and best appointed in America. They are fully 6 ft. square, and each is provided with an additional space partitioned off about 3 ft. wide, for a shower bath, and a basin, the fresh water for which is brought from the adjacent mountains. I took a 15-minute bath in the lake on Sept. 15; the bathing suits are heavy blue flannel and all alike, and very much superior to the dilapidated garment handed one at Coney Island; the water was as clear as crystal, and not as cold as the Atlantic in July or August; one could wade apparently half a mile out before getting beyond his depth; the beach was the purest and softest of sand, no shells to cut the feet and no mixture of mud or street refuse to foul the beautiful water; with both hands under my head and with my feet crossed, I lay on the surface of the water as if lying on an inflated rubber bag; there was no need to move the hands to keep afloat, but one could be towed about, or he could propel himself easily, as if sitting or lying on a board and paddling with his hands. The buoyancy was a continual surprise; the feeling of lightness when one stepped from the water was marked, and the exhilaration after the bath was glorious. I have bathed many times in the Atlantic surf from Coney Island to Atlantic City, but it cannot compare for pleasure with a bath in the Great Salt Sea by the City of the Saints.

I went to this far-away city ostensibly to report the meeting of the Irrigation Congress, which was held, as advertised, on the 15th, 16th and 17th. The Convention was more of a political character than engineering, and did not admit of an extended report in these columns. There is, however, large possibilities in the future of the arid region of the West for engineers, and hence the interest of ENGINEERING NEWS in the subject. G. H. F.

(To be continued.)

PERSONALS.

Mr. BELPAIRE, the noted engineer and Director-General of the Belgian State Railways, has been elected President of the International Railway Congress to succeed the late M. FASSIAUX.

Mr. W. S. MARTIN has been appointed Superintendent of the Owensboro & Nashville Ry.

Mr. E. T. JEFFERY, formerly General Manager of the Illinois Central R. R., has been chosen President and General Manager of the Denver & Rio Grande R. R., with headquarters at Denver, Colo. He entered the service of the Illinois Central in 1856, and remained with that road until he resigned the office of general manager in 1889, having held that position for four years. After retiring from the Illinois Central Mr. JEFFERY was chosen President of the Grant Locomotive Works, which propose to erect works at Chicago, and is also connected with the management of the Columbian Exposition.

Mr. J. F. O'ROURKE, Assistant Engineer on the Chignecto Ship Railway, has been appointed engineer in charge of surveys for the Rapid Transit Commissioners of this city.

Mr. W. T. JENNINGS, City Engineer of Toronto, Ont., has resigned.

NEW PUBLICATIONS.

—Poor's Hand Book of Investment Securities.—A Supplement to Poor's Manual of Railroads. New York; second annual issue, 1891; H. V. & H. W. Poor. Cloth, 6 × 9 ins.; pp. 508; price $2.50.

This volume is intended to supply in a compact and brief manner such information in regard to the securities issued by the several railway corporations of the United States, by the several states, and by the various municipal bodies and incorporated industrial enterprises throughout the country as may be of interest to investors. In addition to this there is a large amount of information about the dividends and interest on bonds paid by railway companies, railway earnings, etc. The matter contained in the tables and statements appears to be very complete and is conveniently arranged for reference.

—Dynamics of the Sun. By J. WOODBRIDGE DAVIS. Woodbridge School Essays No. 1. Published by the Woodbridge School. New York, 1891. 4to. Paper. 97 pp. and diagrams.

This handsomely printed monograph is the first of a series on theoretical astronomy. We can do little more here than to give the subject matter treated on in the present publication. These are—Matter, gravity and heat, the outlying atmosphere and the quiescent atmosphere, solar and planetary atmospheres and planetary magnetism. A series of essays to follow these will deal with planetary electricity, cometary atmospheres, miscellaneous deductions and the theory.

—Annual Report of the Commissioner of Dams and Reservoirs to JOHN W. DAVIS, Governor (of Rhode Island) Jan., 1891. L. M. E. STONE, Commissioner. Pamph., pp. 67, mostly full page illustrations.

This is the ninth annual report on the dams and reservoirs of Rhode Island. Detailed drawings of eight dams are included in the report, making 453 such structures reported upon by Mr. STONE since his office was created. The only accident to a dam or reservoir in the state during 1891 was the failure of the Fruit Hill Reservoir, Providence. This failure has not been brought to the official attention of Commissioner STONE. Of the dams reported upon, Mr. STONE states that those evincing "no cause for anxiety are the exception and not the rule, their leaky condition being the chief cause for anxiety." At the close of this brief report quotations of some length are made from articles in ENGINEERING NEWS on the subject of earthen dams.

—First Annual Report of the Public Improvement Commission, Troy, N. Y. Compiled by W. R. SWEENEY Clerk. 1890. Pamph., pp. 108, map and large folding table.

This report covers the work of the seven commissioners from their organization, June 13, 1889, to Sept. 20, 1890.

The efforts of the commission were largely devoted to sewerage, although much attention and some labor were given to grades and pavements. In 1867 the aggregate length of sewers in Troy was about 6 miles, of which one-third were stone and the remainder brick. During the next 23 years, or until the commission began work, but 11 miles more were added, nearly all brick, from 2 ft. to 6 ft. in diameter. The commission found it necessary to examine nearly all the sewers previously constructed and make profiles and notes showing their size, grade and position. Manhole covers were found from 2 to 6 ft. below the street surface, nearly all of which were located from the inside of the sewers.

In addition to the above work the commissioners visited several cities at their own expense, and inspected their sewers and pavements. The observations made during these visits were supplemented by correspondence with other cities, letters containing questions concerning sewerage, drainage and pavements having been sent to 200 of the principal cities of the United States. The replies to about 50 of these letters, so far as they relate to sewers, are presented in a large table appended to the report. Together the points covered make up a good description of each system, presenting its character and extent, and some valuable figures relating to cost of sewers of various sizes. The figures for cost will be given in another issue.

—Irrigation Statistics of the Territory of Utah.—Compiled and prepared for the Irrigation Congress at Salt Lake City, Sept. 15 to 17, 1891, by C. L. Stevenson, Secretary of the Utah Statistics Committee. Pamph., pp. 36.

This little pamphlet contains much information regarding irrigation in Utah and directly allied subjects. The physical features of the Territory, so far as they relate to irrigation, are briefly described. A few facts are given regarding the Bear River canal and several irrigation projects. Cubic feet of water, California and Colorado inches of water are compared and their equivalents in acre-feet are given. A brief synopsis of Utah laws regarding irrigation is given. The total acreage of land under ditch in Utah is given as 735,226, of which 333,404 acres were actually irrigated in 1890. An additional area of 1,568,774 is estimated to be susceptible to irrigation.

— Report of the Superintendent of the Montreal Water-Works for 1890. B. D. MCCONNELL, Superintendent. Pamph., pp. 147.

The average cost for the past 16 years of raising 1,000,000 galls. 1 ft. high, has been 1.21 cts. by water and 12.9 cts. by steam power. During 1890 74½% of the pumpage was done by water and 25½ by steam power, the average daily consumption being 14,399,800 galls., or 61 galls. per capita. The report contains a summary of statistics after the New England form, a table of average daily consumptions for each month and year from 1857 to 1890, inclusive, and results of numerous analyses of water, besides the review of the year's work and other matter of local and general interest.

—Toronto Water-Works.—Annual Report of the Superintendent (WILLIAM HAMILTON) for 1890. Pamphlet, pp. 227, illustrated.

Those interested in pumping statistics will find this report a valuable one. Besides the detailed figures for the year 1890 there are presented for each of the years 1876 to 1890, inclusive, the total pumpage, quantity and cost of fuel, average daily pumpage, average daily consumption of coal, and gallons pumped per pound of coal. The report contains an illustrated description of the new intake conduit, consisting of 4,660 ft. of 48-in. and 6,427 ft. of 60-in. steel pipe. The 48-in. pipe nearly parallels and will be used in connection with the 36-in. cast-iron conduit extending from the pump-well across the harbor to the connecting crib at Hanlon's Point. The 60-in. pipe is substituted for the old 48-in. wooden conduit from the connecting crib across Blockhouse Bay and an island to the island crib. The latter crib is fed by a 72-in. lake intake. The new conduit is of ⅜-in. single riveted Scotch steel boiler plate, in 57 ft. lengths. There are 65 flexible joints in the 48 and 15 in the 60 in. section. The illustrations show details of the 60-in. joints.

—Report of the Agricultural Experimental Station Fort Collins, Col., for 1890. Pamph., pp. 227.

Pages 57-155 of this pamphlet are taken up with the report of L. G. CARPENTER, Professor of Irrigation Engineering in the State Agricultural College, with which the experimental station is connected. Professor CARPENTER'S report relates to irrigation and meteorology, and contains much valuable matter on each subject, a large number of meteorological tables being given. The water supply for the year is first discussed, after which the duty of water is taken up. Irrigation statistics for 1890 estimate the area under ditch to be 4,068,000 acres, of which 1,635,000 acres is estimated to be irrigated. The former figures are about 14,000 acres less, and the latter about 100,000 acres more than those given in the last State Engineer's report. The mileage of irrigating canals in the state is estimated at 6,300, and the total cost of canal construction is estimated at $10,980,000. The report contains a list of the works directly or indirectly relating to irrigation which are either in the college, station or the Professor's library.

—Report of the State Engineer of Colorado for the years 1889 *and* 1890. *Part I.* J. P. MAXWELL, State Engineer; J. S. TITCOMB, Deputy State Engineer. Pamph., pp. 629.

This report, like preceding ones, deals almost wholly with irrigation. The bulk of the volume is taken up with the reports of the superintendents of water divisions and commissioners of districts. There are six divisions subdivided into districts with a total of at least 67 of the latter. According to the report there are 4,082,738 acres of land under ditch and 1,544,585 acres of irrigated land in Colorado.

Eight gaging stations are reported upon, and daily gagings, more or less complete, are given for the years 1889

and 1890. For Station No. 1, Cache la Poudre River, the record is complete for each day of both years.

The duty of water is briefly discussed, and figures are given showing the mean discharge of six streams from May 20 to Sept. 20, 1889 and 1890, the area cultivated and the duty in acres per cubic foot. This duty ranges from 168 to 436 acres, but is based on the amount of water available and total acres irrigated, and is, therefore, but approximately correct, as it is assumed that the whole flow of the streams during the period named was put upon the land. The duty is, therefore, too low, at least in some cases.

The reports of the several superintendents and commissioners contain tables of detailed information regarding the ditches, reservoirs and artesian wells within their districts.

In October, 1889, measurements to obtain the amount of seepage water received and carried by the South Platte and Cache la Poudre Rivers were made by the department, in coöperation with Mr. E. C. HAWKINS of the U. S. Geological Survey. In October, 1890, Mr. HAWKINS, with Mr. L. R. HOPE as assistant, made similar measurements for the department. Tables are presented showing the results of these measurements. Without going into details it may be said that the figures show seepage water returned to the stream to be an important factor, at least in the Platte River system.

For detailed information regarding irrigation works the biennial reports of the State Engineer of Colorado are far ahead of any similar publications in this country, and the current report seems even more complete than the preceding ones.

—*Report of the Engineer Department of the District of Columbia for* 1889-90. Lieut.-Col. H. M. ROBERT, U. S. A., Engineer Commissioner. Pamph., pp. 255 and several folding sheets of maps, diagrams and illustrations.

A large amount of interesting information regarding the public works of the district and the improvements and extensions made in 1889-90 is given in this report. The matter in the text and tables is supplemented by maps showing in detail the character and extent of pavements, the distribution of water and the sewerage system. Sections of pipe and main sewers are given, as is a drainage diagram, showing the discharge of conduits of various diameters and grades for specified drainage areas. Another diagram compares the maximum amount of rainfall assumed to reach the sewers of the district by the Board of Public Works in 1871, the Engineer Department in 1878 and again in 1887, and Board of Engineers—Messrs. HERING, GRAY and STEARNS—in 1890. In the order named the assumption was for, say, 500 acres, 500, 1,000, 565 (about) and 620 (about) cu. ft. per second.

The volume contains reports by Capt. J. L. LUSK, Assistant to the Engineer Commissioner, and D. E. MCCOMB, Superintendent of Sewers, on sewage disposal. The latter report is accompanied by a general plan of proposed sewers, and an appendix contains brief notes on some of the more important sewage works in England and the sewerage system of Paris. Twenty-four closely printed pages of the volume contain specifications for standard pavements and street construction materials.

SOCIETY PROCEEDINGS.

Western Railway Club.—At the first regular fall meeting, on Sept. 15, a paper on "Air Brake Practice" was read by Mr. G. W. Rhodes. The paper was a criticism of the standard code of rules for the government of employees in the handling and care of the airbrake, proposed for adoption by the Master Car Builders' Association. The first point taken up was the rule that each employee should be required to have in his possession a certificate of competency to perform the duties required of him in connection with the operation of the air brakes, such certificate to be given after examination by a competent officer. This was objected to on account of legal complications which might arise, and because the certificates might be kept and produced notwithstanding its holder had forgotten important features of the subjects on which he was examined. Again, in an accident the non-production of a certificate might make a railway responsible; and in case of strikes or similar troubles, men would have to be taught things very rapidly, and would be given certificates for knowledge learned by rote. Mr. Mackenzie spoke in favor of the certificate plan, and another member suggested that a renewal of the certificate every six months might cover some of the objections presented.

Mr. Rhodes next proposed that the limit of maximum and minimum travel of brake pistons be made 6 ins. and 9 ins. instead of 4 ins. and 8 ins., as in the code presented for adoption. The reasons were, first, that as a matter of fact pistons will often run to full stroke (12 ins.) before the slack is taken up, or a variation of 8 ins. between the shortest and longest stroke, while if the shortest stroke is 6 ins. this variation is reduced 2 ins.; second, that if 1 ins. be made the maximum travel of the brakes when on with their full force after being newly adjusted, then when the brake is applied lightly for ordinary service stops the piston will travel only 2 or 3 ins., the "leakage groove" in the brake cylinder will not be covered, and the brake will leak off, or there will be great waste of air. President Barr thought the rule ought to prescribe an average limit rather than a maximum and minimum limit, and inspectors should maintain the average as closely as possible.

The next criticism was that in testing brakes the engineer should exhaust all the air from the train pipe. Mr. Rhodes' reasons were: first, that in this way brakes with sluggish or dirty valves would work, when with only a service application the brake would not work and the car would be cut out. It may be argued that the car brakes should be made to work before leaving the station; but as a matter of fact this will not be done and the car will go on with its brake cut out; whereas if left alone, it might have worked for emergency stops, though not for service stops. In the second place the engineer learns to gauge the length of his train pipe by letting all the air out, by the sound of the exhaust. He can then detect the cutting off of any part of the train by the closing of train pipe cocks. Mr. Rhodes described one grade crossing collision which would have been avoided had the engineer kept himself posted as to the length of his train pipe by watching the exhaust.

The next point criticised was the recommendation to apply the brakes at first with only 6 to 8 lbs. reduction, in trains with air-brake cars bunched at the head, to take up the slack. Mr. Rhodes would take up the slack by closing the throttle before applying the brakes at all. Mr. Barr said that many of the best trainmen applied hand brakes near the head of the train, before applying air brakes, for the same reason.

The manner of making a service stop is specified in the next paragraph, and the brake is directed to be released just before coming to a stop. It should be stated that this refers only to trains with air brakes on all cars.

In the instructions for cutting out a car an instruction should be added to leave the bleed cock open.

The requirement that no train may be started with the brakes on any car cut out or defective without special orders from the proper officers, should be modified by adding, "as far as practicable." Trainmen must be allowed a certain amount of discretion. Mr. Mackenzie said the idea among trainmen that if a brake is sluggish they must cut out the car at once is much too prevalent, and imperative rules to prevent this are needed. If a car is unsafe to run, it should be placed at the rear of the train and a man placed in charge until a point is reached where it can be fixed or sidetracked.

The paragraph on "burst hose," requiring the hose to be replaced and the brakes tested before proceeding, should be qualified by the words, "provided the train is in a safe place."

Concerning drainage of the pipes, etc., Mr. Rhodes would insert the following in the rules:

The train pipe under the tender must always be blown out thoroughly before connecting with the train.

This is very important. The dirt, oil and grease from the pump, and the sweat and rust from the pipes while the engine is in the round house all collect under the tank and unless the above precaution is taken will be blown right into the first car connected to. The result of neglect in this matter is clearly seen by comparing the triple valves on baggage cars with those on Pullman cars. Let any man who doubts this place his hand over the tank hose and then blow the pipe out. The dirt he will catch will be very convincing.

Several other minor changes in the code were recommended by Mr. Rhodes, and he also called attention to the fact that the rules for the use of compressed air train signals contained in the report as presented to the Association were not authorized by the Association and dealt with a matter which the Association had never taken up. They should, therefore, be omitted from the code in the revision thereof.

It was announced that Mr. Rhodes' paper would be discussed at the October meeting, and it was voted that all air brake experts connected with the different roads be invited to attend the meeting; also that experts from the different brake companies be invited to attend. The question of giving supply men the privileges of the floor was deferred until the October meeting. At that meeting Mr. Barr will present a paper on "Water Purification," and papers have been promised during the year by Messrs. P. H. Peck, John Mackenzie, W. H. Lewis, C. A. Schroyer, Jno. Hickey, A. M. Waitt and D. L. Barnes.

The election of officers resulted in the choice of the following: President, Peter H. Peck; First Vice-President, W. H. Lewis; Second Vice-President, Joseph Townsend; Secretary, W. D. Crosman; Treasurer, Allen Cooke. The membership of the club is now about 225. The expenses during the year were $1,161.17, and the club has about $100 cash on hand, besides unpaid dues and advertising amounting to about $600. Secretary Crosman submitted his resignation, action on which was deferred to the October meeting.

American Society of Civil Engineers.—The regular meeting was held Oct. 7, Vice-President A. Fteley in the chair. The Secretary announced the death of Mr. W. L. Scott.

On motion of Mr. Brush a resolution was adopted requesting the Board of Directors to consider the advisability of terminating the presentation of papers and discussions at the second meeting of the month at 9 P. M., in order to have the collation served earlier and give more time for social intercourse. Mr. Crowell thought it advisable to take measures to increase the acquaintance between members, and that in some cases the reading of papers leaves little time for discussion or for social enjoyment after the meeting. Mr. Harris suggested that if one meeting was given up to social features and a great part of the other meeting to business affairs there would not be much time for papers. He did not approve of the present plan of having collations or of extending it any further. He thought the oral discussions very valuable, as many casual remarks are made in the heat of discussion which might not be called forth in written discussions.

A paper on "Screw Steamships and Tow Barge Efficiency on the Northwestern Lakes of America," by Mr. J. R. Oldham, N. A., was read by the Secretary. The paper drew comparisons between the ordinary type of freight steamer and the "whaleback" steamers about which so much has been said. The "whaleback" steamers make good speed with low power and small fuel consumption, and the "whaleback" barges tow very easily. Prof. Thurston, in a written discussion, stated that the fast Atlantic steamers should carry only passengers and first-class freight which would bear high charges, while the "whalebacks" are adapted for slow freight bearing low charges.

A paper on "Some Recent Experiments with Dynamite on an Ocean Bar," by Capt. O. M. Carter, was then read by the Secretary. The experiments were made on the ocean bar at Brunswick, Ga., but were practically unsuccessful. Mr. Lewis Haupt, in a written discussion, stated that the results were what might have been anticipated. Mr. Brush referred to experiments made to remove the bar in New York harbor by a series of water jets to stir up the sand, but the tidal current was not strong enough to carry away the matter in suspension, and it merely settled again. Mr. Collingwood referred to successful experiments made on the New York bar with a system of pumping up the sand by very powerful centrifugal pumps, a plough on the end of the suction pipe stirring up the material. The pumps would draw up and pass large and heavy stones and other bulky matter. Mr. Read, a member of the American Institute of Mining Engineers, said that the plan described by Mr. Brush was got up by Gen. Roy Stone, who also proposed to use jets as auxiliaries, and to force the matter up by injectors, but this latter plan failed owing to defects in detail. Capt. Eads took out some patents on this subject. A current of certain velocity is required to carry away grains of a certain size and weight held in suspension, and the results of experiments in this direction made in connection with the subject of ore separation have been published in a book by Professor Rittinger, of Germany. A book by Mr. Kunhardt, on the separation of ores, published originally in the papers of the American Institute of Mining Engineers, gives the main results of the experiments, and the matter is referred to in other papers on the same subject in the transactions of the institute.

At the next meeting will be presented papers on "The Prevention of Water Waste at Rochester, N. Y.," and "The Hemlock Lake Conduit at Rochester, N. Y.," both by Mr. Geo. W. Rafter.

The following candidates were declared elected:

Members: Caspar W. Haines, Intercontinental Railway Commission, Guatemala; Charles F. B. Haskell, Asst. Eng., Great Northern Ry., Wenatchee, Wash.; Alfred A. Stuart, Res. Eng., Central Railway & Bridge Co., Newport, Ky.

Associate Members: Frederick W. Abbott, Chf. Eng. of Section No. 2 of Tequitquiac Tunnel, Zumpango, Mexico; George E. Gifford, King Iron Bridge & Mfg. Co., Cleveland, O.

American Society of Railway Superintendents.—At the meeting on Oct. 12, at the Hotel Brunswick, New York, there will be presented reports of standing committees on Roadway, on Machinery, on Transportation, and on Railway Signaling. Also an address by Mr. Willard A. Smith, Chief Department of Transportation Exhibits, World's Columbian Exposition, on "Railway History and Plans for Representing Transportation Interests at the World's Fair," and a paper by Mr. W. G. Wattson on "Economy in Train Service." The following are the topics for discussion:

Continuation of discussion on experience in working under the standard code of train and telegraph rules; methods of examining and instructing railway employees; block signaling; practical tests of railway appliances.

American Institute of Mining Engineers.—At the meeting this week at Glen Summit, Pa., the programme for which was given in our issue of Sept. 19, some important papers on the magnetic concentration of iron ore and its use in blast furnaces, were presented, which we shall publish shortly. Two of the papers prepared for the meeting, on the use of electric power in one of the Aspen, Col., mines, and on the limits to the utilization of anthracite culm for making producer gas, are reprinted elsewhere in this issue.

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AND

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COMING TECHNICAL MEETINGS.

Atlanta Society of Civil Engineers.—Oct. 13. Secy., Parker N. Black, Room 39, Capitol Block.
Denver Society of Civil Engineers.—Oct. 13. "Municipal Engineering." Secy., Geo. H. Angell.
Northwestern Society of Engineers.—Oct. 13, Rooms, Occidental Block, Seattle. Secy., E. H. Warner.
Civil Engineers' Association of Kansas.—Oct. 14. Secy., J. C. Herring, Wichita, Kan.
New England Railroad Club.—Next meeting, Oct. 14, at United States Hotel, Boston. "Lighting of Passenger Cars." Secy., F. M. Curtis.
Engineers' Club of Cincinnati.—Oct. 15. Secy., J. F. Wilson.
New York Railroad Club.—Oct. 15. Rooms, Gilsey House.
Scandinavian Engineering Society of Chicago.—Oct. 15. Secy., T. G. Pihlfeldt, 118 Adams St.
Montana Society of Civil Engineers.—Oct. 17. Helena.
Western Railway Club.—Oct. 20. Rooms, Rookery Building, Chicago.
Engineers' Society of Western Pennsylvania.—Oct. 20. Secy., J. H. Harlow, Pittsburg, Pa.
American Street Railway Association.—Annual convention at Pittsburg, Pa., Oct. 21, 22, 23. Secy., Wm. J. Richardson, Brooklyn, N. Y.
American Society of Civil Engineers.—Oct. 21. Secy., Francis Collingwood, 127 East 23d St., New York.
Engineers' Club of St. Louis.—Oct. 21. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Governor Thomas, of Utah, in his speech before the Irrigation Congress at Salt Lake City, graphically depicted the necessity for irrigation in that region and for radical change in existing laws and methods. Out of a total land area of 56,601,600 acres in Utah only 2,304,000 acres, or about 4 per cent. can be brought under cultivation. And the total area of land that can at present be watered is only about 720,000 acres. This latter small area must now bear the burden of supporting the territorial government, for fifty millions of acres are valueless, except a portion suitable for grazing purposes, and almost two million acres of arable land lie unused and unremunerative, owing to the lack of water. To make this land available and triple the resources of the territory, storage reservoirs and thousands of miles of canals must be built, entailing an expense out of all proportion to the revenues from the present limited area of land under cultivation. To await the action of foreign syndicates in developing this territory is slow work, and usually means a complication of interests and the maximum cost of water to settlers, with a correspondingly discouraging influence upon the growth of population. This development, to be systematic, fair in its apportionment of water and to do most good to the greatest number of citizens of the territory, should be the work of the territorial authorities, planned by their engineers, built and controlled by them, says Governor Thomas.

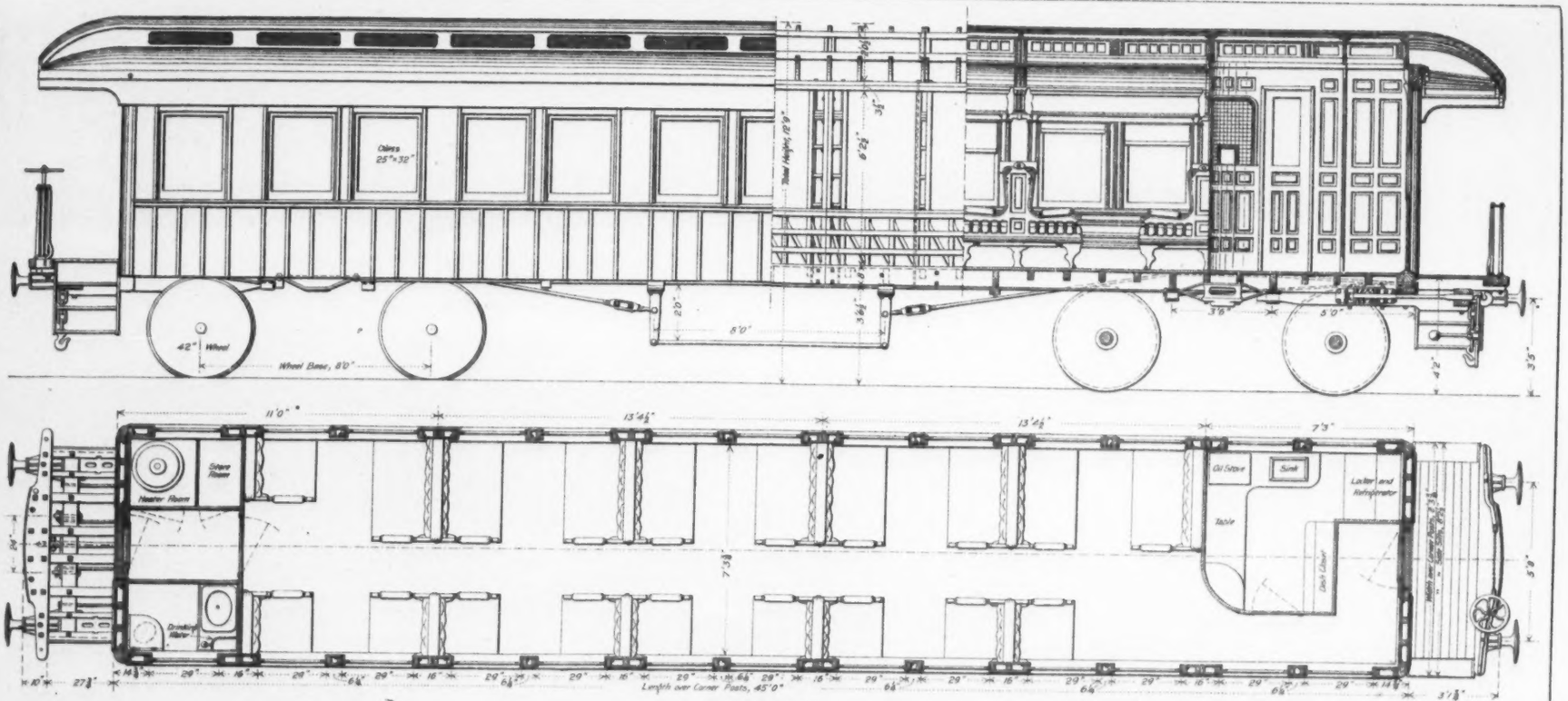
To accomplish this vast work, not only in Utah but in the majority of the far Western states and territories, means must be provided; and, as mentioned in our last issue, the best means to this end seems to be the ceding of the public lands for this purpose on the lines indicated in the resolutions of the Irrigation Congress. The past policy of the general government has not been, and should not be, to regard these lands as a source of immediate profit, but as lands held in trust for the common good of all citizens. This common good means the settlement of the land, and this settlement can only come in the arid regions of the West when water is first brought to the lands. There are two ways of doing this; one is to tax the whole people of the United States for the irrigation works of individual states or territories; the other is to devote public property in the sections needing this aid to the development of these regions. There can be little question as to which plan is best, and to which there should be the least objection. While the whole country has an interest in public lands, no matter where situated, the whole country also has a much greater interest in the development, settlement, and increased resources and distributed wealth of any section of the country that can be benefited by reason of the utilization of the public land in this development. To-day many millions of acres of fertile soil in the United States only await irrigation to fit them for the support of a teeming population, and would add to that extent to the wealth of the nation. It is sincerely to be hoped, therefore, that the general government will earnestly take up and discuss to a satisfactory end the plan and policy outlined at Salt Lake City, a policy which practically applies to the whole arid regions of the West.

But the problem which will be submitted to Congress is a knotty one, as has been before remarked. The three states of Colorado, Wyoming and Montana contain within their borders the sources of practically all the interstate waters lying west of the 97th meridian, and it will not do to hand over the absolute control of these waters to the three states named regardless of the just demands and rights of the territory lying to the east of them. The timber lands now protecting these sources must also be preserved for the benefit of all needing water, and regardless of territorial boundaries, and the law passed by the last Congress, which authorizes the protection of these forest areas by the general government, cannot be safely changed. As a consequence, while doubtless much of this public domain may be ceded to the states in trust and for the special purpose of irrigation development, it is evident that the general government, as the representative of the whole people, must couple the cession with conditions that will insure a just apportionment of water and the preservation of water-storing areas. Herein will come the difficulty; and unless the authorities at Washington and those in the various state capitals in the arid region work together and for the common good, there will be little, if any, improvement on present practice.

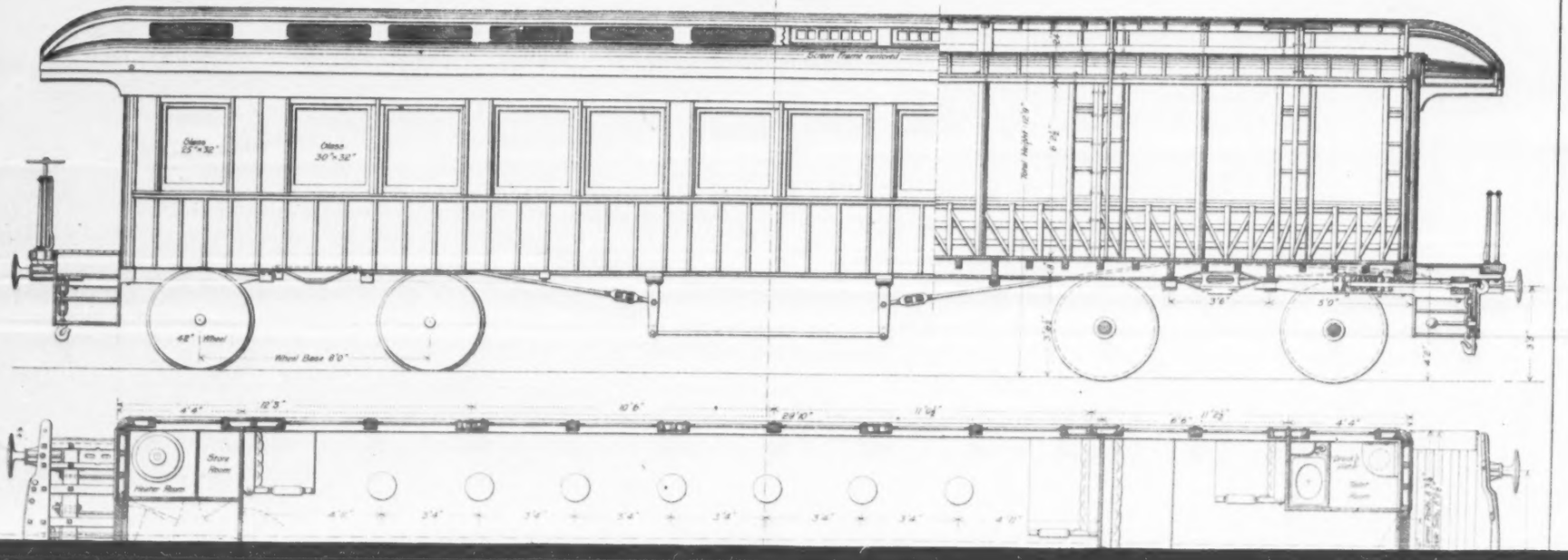
The comparison of English and American railways is a question to the discussion of which there is no end, and it is of mutual benefit that this discussion should be continued, as it throws light upon both sides of the question, provided always that the discussion is carried on by men who understand what they are talking about, and are able to put prejudice aside and acknowledge the bad points of their own view of the case and the good points of the other view. In our correspondence columns this week will be found a letter from an English writer who wishes to obtain some information for a paper he proposes to write comparing American with European railways. From the letter it appears evident that the writer does not understand American railways, but will draw his deductions from such details as may be furnished him. This is not the right way to enter upon such a subject, and a paper written in this way will be of very little value, and may be positively mischievous, while it will be no credit to the author. We recall a case in which an English engineer stated in a paper or book that in America there was practically but one type of locomotive, namely the "American" or eight-wheel, having four coupled wheels and a leading four-wheel truck. It is probable that he deduced this idea from the fact of the type being termed the "American," whereas a more misleading or grossly inaccurate statement could hardly be made respecting American locomotives. He apparently did not know of the mogul, ten-wheel, twelve-wheel or "mastodon," consolidation and decapod types, though he might easily have ascertained the fact that America has more than one type of locomotive. Again, in England there is a general impression that the tracks of American railways are of a very light character, and perhaps our correspondent will be surprised to learn that some of our leading railways are using rails weighing from 75 and 80 to 85 90 and 95 lbs. per yd., and that we have tracks here that are superior to any English tracks for the reason that while they cost less to build they are fully as substantial and efficient in service. This is only one point, mentioned as an instance, but to go fully into the matter would require a very much longer and more detailed article than we are prepared to give just now. The way to get at the facts of the matter, and to do any useful work in this discussion for promoting improvement in railway work, is not to write up a more or less interesting paper based upon hap-hazard information, but to study conditions, methods and material in both countries, not merely by a brief visit and by traveling in a parlor car, but by giving sufficient time for the investigation and comprehension of reasons and results. If this cannot be done, our correspondent will do better to select some work with which he is personally familiar for the subject of his paper. In our issue of July 4, 1891, we gave a long article upon English and American railways, which was based upon observations made in both countries, and which was a fair and careful presentation of the matter in general. A very good idea of the progress of American railways may be obtained by studying the volumes of Engineering News, but no amount of such study will make up for lack of personal knowledge of the subject in drawing comparisons.

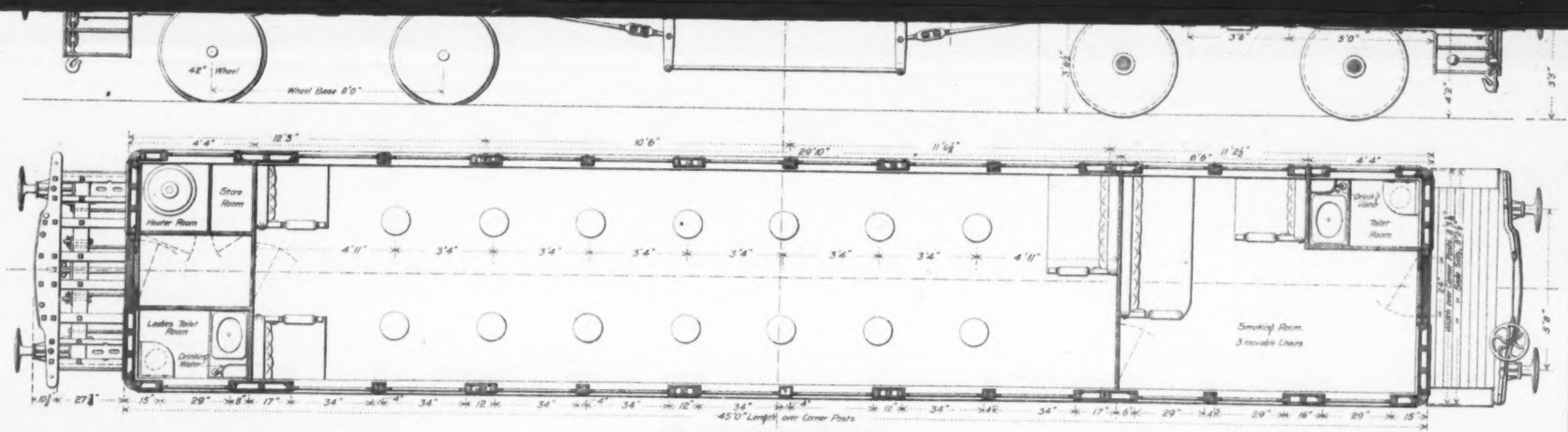
Diagonal Avenues in Cities.

A proposition is again before the Councils of Philadelphia that will undoubtedly shock the conservative local element accustomed to the gridiron street formation of that city. This is the revival of the proposition of three years ago to cut a boulevard, 150 ft. wide and one mile long, diagonally across the section of the city lying between

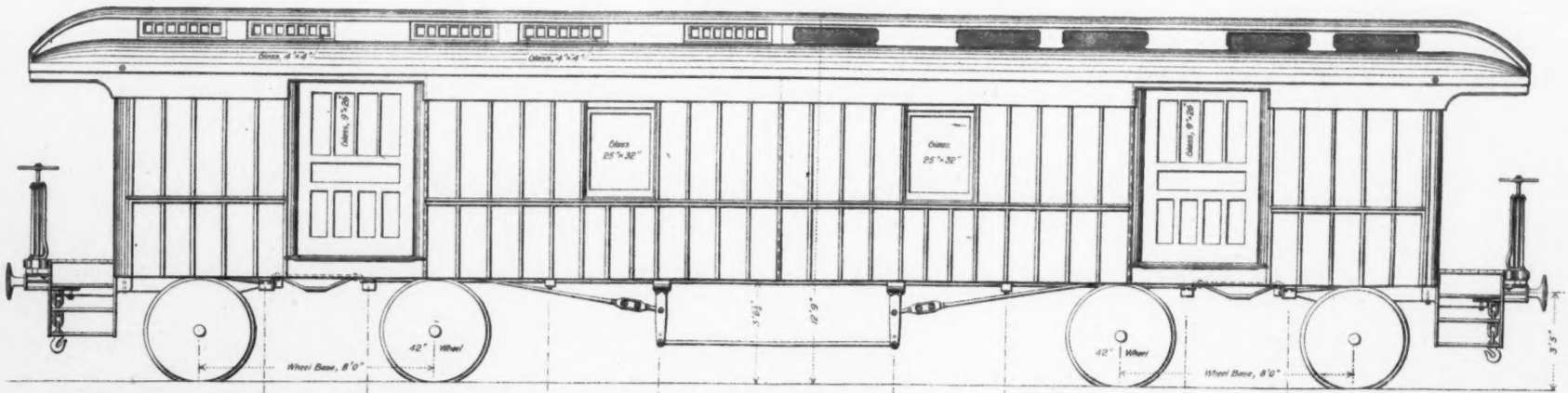

Glass 25"×32"
Wheel Base, 8'0"
Heater Room
Store Room
Drinking Water
Oil Stove
Sink
Table
Locker and Refrigerator
Length over Corner Posts, 45'0"

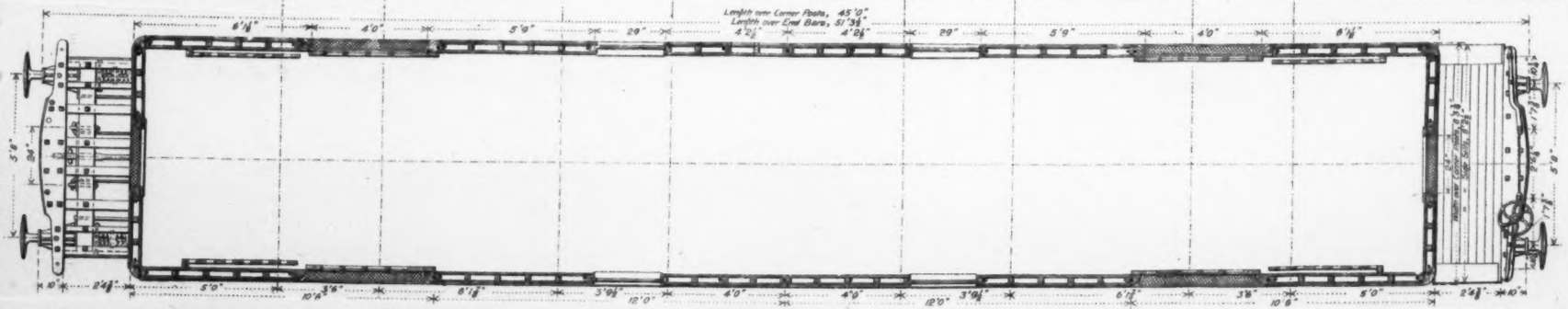
BUFFET CAR.


Screen Frame removed
Glass 25"×32"
Glass 30"×32"
Wheel Base 8'0"
Heater Room
Store Room

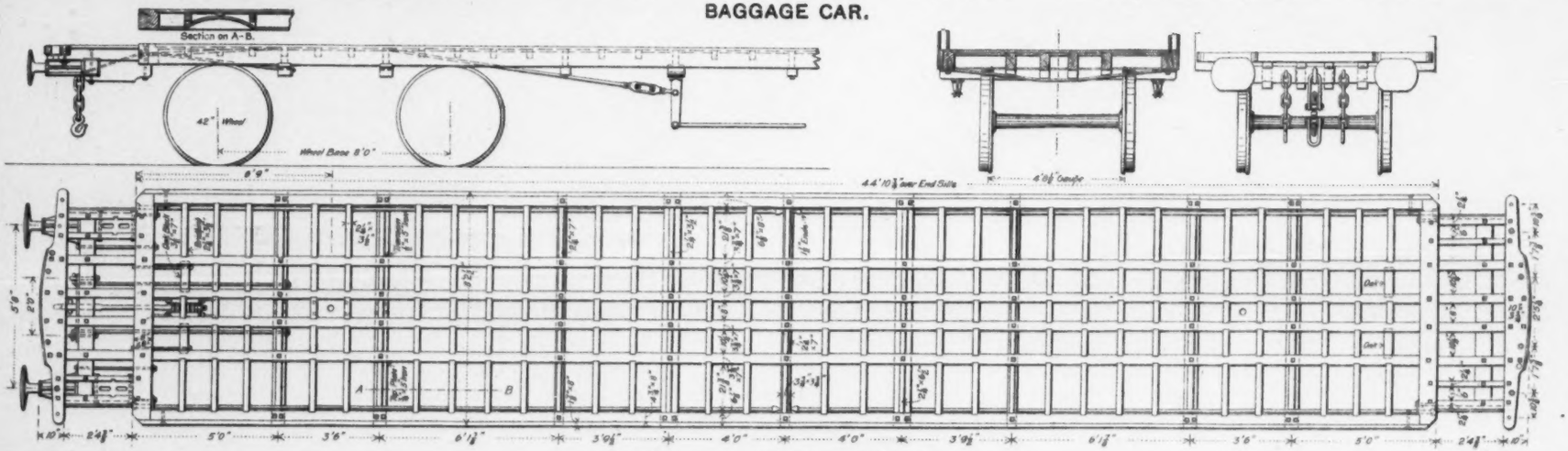


DRAWING-ROOM CAR.





BAGGAGE CAR.



PLAN OF FLOOR FRAMING.

AMERICAN CARS FOR THE SOUTHEASTERN RAILWAY, ENGLAND.

GILBERT CAR MFG. CO., TROY, N. Y., BUILDERS.

CHAS. HART & SONS, LITH. 26 VESEY ST., N. Y.

the new public buildings and Fairmount Park. The primary object is to obtain a more fitting entrance to a magnificent park that, as someone once said, is a paradise of a park, but can only be reached through a purgatory of narrow streets lined with the poorer class of houses and small shops. The estimated cost is set down at $3,000,000, based upon the present assessed valuation of the property to be taken. But as a boulevard of the kind proposed would entirely change the character of the part of the city intersected by it, and would soon be lined with handsome and costly buildings, the cost is little more than nominal when compared with the increased revenue to the city, from the "betterments" and gain in taxes. Philadelphia, like other of our older cities, has adhered too rigidly to the original plan of its founder, and with the exception of two ancient country roads, which have been built upon and gradually assimilated as main avenues of diagonal travel, the citizen must always go around the two sides of a triangle in passing between points diagonally opposite.

The rectangular formation of streets is well enough for a beginning, and is perhaps the easiest for original settlement and apportionment of property. It has its marked advantages in the systematic numbering of houses, naming of streets and disposal of certain classes of pipes under the streets, and in the early stages of municipal development the distance between given points is not a question worthy of any special remark. But as the city grows in area the gridiron plan more and more fails to meet the requirements of rapid traffic, and the want of diagonal streets is more keenly felt. When these latter do exist, sometimes accidentally as in the case of the two country roads transformed into avenues and mentioned above, the great traffic upon them proves the necessity for their being, and they were only allowed "to mar" the symmetry of the older plan by reason of this necessity and their constant use.

The city of Washington is our one notable example of a city well planned before building was commenced, and in which some thought was taken of the demands and convenience of a population yet to come. In this city, while the general plan for the smaller streets is rectangular, these streets are intersected by a primary system of wide diagonal avenues radiating from fixed centers. The resultant effect is a number of handsome smaller parks, a very marked addition to the appearance of the city and above all streets which lead in the direction of main threads of travel, which usually radiate from centers of business or resort to the residence portions of a city. The streets of some other cities, like Boston for example, simply grew with the population, and go to the other extreme, as compared with the rectangular plan. They are very irregular, running in all directions and totally without system, and as a rule are narrow and unsuited to the demands of modern civilization. Buffalo presents an example of the radiating plan, which, though in great part the result of accident and the extension of country roads leading to an original settlement on the lake shore, is yet fairly well adapted for the circulation of a large population. In the West the rectangle is the rule in street formation, with the difference that, as these cities are comparatively modern, the value of a liberal width of street was recognized while land was still cheap. New York, thanks only to the attenuated form of Manhattan Island, is better off than many of the older cities; though the present search after increased rapid transit facilities proves to us very conclusively that one central thoroughfare fails to meet the requirements of present conditions.

In fact, in all the older cities of the United States, there is a constant effort to improve upon faulty original location and width of streets. Boston took advantage of a disastrous fire to eliminate some of the crooked and narrow lanes that city inherited from colonial days, and other towns are cutting wider and straighter avenues whenever opportunity offers. But the time is not far distant when more radical measures will have to be adopted, and among these the most useful, and in the end the most economical will be the creation of highways cutting diagonally the existing network of rectangular city blocks. In some cases modern structures of great mass and value will either make such improvement practically impossible or of enormous cost. But as a rule, such thoroughfares would simply remove antiquated and comparatively cheap buildings which would soon be replaced by others more in keeping with modern progress and yielding a correspondingly increased revenue to the owner and to the city.

We want a Baron HAUSSMANN in many of our cities of early origin; and while we fortunately have few of the huddles of old houses and labyrinthine streets that the third NAPOLEON caused to be removed from Paris, the example he set is well worthy of imitation, to the extent of our power and means of execution. NAPOLEON III., between 1852 and 1870, brought about the reconstruction of about two-thirds of ancient Paris, and no one will now deny that the enormous outlay then made necessary was one of the best investments ever made by the French people, whether it is viewed from an æsthetical, a sanitary or a commercial standpoint.

The advantages to be gained from a studied and intelligent departure from the rectangular street formation may be stated as follows: First, ease and directness of access to points remote from a business center, and situated diagonally as regards that center and the rectangular block system. Valuable time is lost and business is made to suffer by forcing traffic to take the two sides of a right angled triangle, when the hypothenuse could be opened to it. Then bordering property is improved and not destroyed as some would believe, by making it easier of access and placing it on a thoroughfare that is bound to attract traffic and trade. And finally every expenditure that enhances the beauty of a city and makes it more attractive to the resident and to the stranger is a solid investment that can be measured in cash returns. The present beauty of Paris, a beauty which is recognized by all nations, and attracts the traveler and his dollars to that city, is due entirely to its wide, tree-planted boulevards, its fine public and private buildings that are displayed to the best advantage, and to the studied irregularity of its streets. A clump of trees, a small park, a group of statuary or even a simple patch of green grass, at the intersection of streets, is worth all the money it costs, and is worth much more to the whole community than the mere space for bricks and mortar which it supplants. These openings combined with broad thoroughfares, are the lungs of a city; they give breathing room, and their creation in modern times often removes a plague-spot that in the nurture of disease costs more than the improvement suggested. Diagonal streets thus not only add greatly to the convenience of traffic and its circulation, but they relieve the city from the dull monotony of the rectangular street formation, and give abundant opportunity for civic adornment, which latter is almost as important.

The constant tendency in our large cities is to greatly increase the density of population, crowd more and more people on a given unit of area, and to do this by erecting enormously high and enormously costly structures for business and resident purposes. Much of this tendency is due to a want of proper facilities for the rapid circulation of the population, and to the enhanced value of property in business centers resulting in this desire to concentrate interests. The value of real estate is measured directly by the means of communication furnished, just as the construction of elevated roads between the Battery and Harlem, in this city, converted non-remunerative areas of rock-covered soil into valuable building lots, and has covered this soil with a dense population in a few years. Rapid transit includes not only the means for comparatively fast travel, but it means also the most direct route between given points, and it is here again that diagonal avenues often become a practical necessity.

Give people the means of rapidly traveling about, both by elevated or underground structures and on the street surface, and permit commerce to move on wide and direct avenues to points of distribution, and the result will be a broadening of the area of business territory, and a corresponding reduction in the necessity for piling four or five business houses one on top of the other. If we take the whole area of any city and compare the portion that is crowded with trade and enormously valuable per unit of area, with the other parts where land is comparatively cheap, we find that any means of more nearly equalizing these values will be profitable to all concerned. It is just here that street formation comes into play, and if our remote ancestors failed to realize, through no especial fault of theirs, the enormous growth and traffic of American cities, it is our duty and our profit to correct these blunders as rapidly as we can. For a newly started town almost any plan will do that fairly fits the natural topography; but with the experience of the past before us, it is only wise to pay much more attention to this original location or to the extension of street lines than is now usual.

In many cases the better plan costs no more at the beginning than one that will sometimes give trouble, and we noticed a case of this kind lately in a newly founded New Jersey seacoast resort. The builder of this town of Como commenced with an aggregation of sandhills bordering the seashore. The only existing road ran parallel to the beach, and most men would simply have used this road as a base line and have started the streets of the new town accordingly, with all lines parallel and at right-angles to the beach. But this builder stopped to think about it, with the result that he twisted all of his streets so that they struck the beach at an angle of 45°, though the general rectangular block system was maintained. As a consequence a view of the ocean is obtained on looking down any street, and the back streets are almost as desirable in this respect as would have been the one facing upon the water, on the parallel plan. By a little thought he increased the general value of his property by more equally distributing a desirable feature of the location. This is only one instance among many showing the material advantage of intelligent care and forethought in laying out new streets; and while each individual case will demand its especial treatment, the engineer must stop to think whether the plan that is easiest to start with and gives him the least trouble, is the best plan for the future. He will find that it pays to study and to think over the solution of the problem laid down.

Plans for New York City's Rapid Transit Railway.

The Rapid Transit Commission of New York City has this week made public the reports of its engineers as to the best plans of construction for the projected system of rapid transit railways (whose routes and general features have been heretofore laid down), together with the criticisms of four consulting engineers upon these plans.

The Rapid Transit Act, which provided for the appointment of the Commission, and laid down its duties and methods of procedure, declares that the Commission "shall determine and establish the general plan of construction. Such general plan shall contain such details as to manner of construction as may be necessary to show the extent

to which any street, avenue, or public place is to be encroached upon, and the property abutting thereon affected."

It is further provided that in preparing detailed plans and specifications for the construction, the Commission may, in its discretion, include provisions for subways for sewer, gas, or water pipes, electric wires, etc., whenever necessary in order to permit of the proper construction of the railway.

Whether it does this or not, however, the company constructing the road must pay all the expenses of reconstructing, readjusting and supporting any sewer, water pipe or other subsurface structure interfered with by the construction of the road.

It will be seen from this that if the road can be "properly constructed" without building a subway for pipes and wires, then the Commission has no authority to include plans for such a subway. The Chief Engineer to the Commission, Mr. WM. E. WORTHEN, Past Pres. Am. Soc. C. E., has, by direction of the Commission, prepared plans for a railway with four tracks on a level, which he holds can be "properly constructed" by tunneling beneath the surface with the aid of a flat roof shield, driven in advance of the tunnel heading and at a distance of about 8 ft. below the street surface.

The Principal Assistant Engineer to the Commission, Mr. W. B. PARSONS, has, by the direction of the Commission, prepared plans for a double-deck structure, which he describes in his report elsewhere published. To "properly construct" such a railway Mr. PARSONS holds that a subway should be provided for the disposal of the pipes and wires beneath the street, and he therefore provides for a pipe gallery between the two upper or local tracks of his double-deck road.

Upon the plans as presented by these two engineers, the commission asked the opinion and criticism of Messrs. OCTAVE CHANUTE, THEODORE COOPER, JOSEPH M. WILSON and JOHN BOGART. It is sometimes the case that the report of consulting engineers expresses little but a formal approval of the working engineers' plans, when exhaustive criticism is really needed. The Commission guarded against this here by asking opinions as to the merits of two widely different systems of construction; and if their desire was to find out all the weak points as well as the strong ones of each proposed detail, certainly their desire has been gratified, for a more decided case of disagreement among doctors could hardly be found.

Doubtless the most important point which must be decided is whether a subway is to be built for the pipes and wires under lower Broadway in connection with the rapid transit road. Everybody agrees as to the great need for an efficient system of subways and as to the benefit to be derived from them; but the question is whether its construction should be undertaken in connection with a rapid transit railway.

The question is one to be considered from the financial and legal side and as a question of policy as well as from the point of view of the engineer. As stated above, if the road can be "properly constructed" without building a pipe subway in connection with it, then the Commission is not authorized to build the subway. On this point the weight of authority is pretty evenly divided. Mr. WORTHEN'S plan has of course as a chief merit that it avoids all complications and interference with the pipes. Messrs. WILSON and BOGART acknowledge the great need for a subway, but think it wisest to treat it as a separate enterprise at some future time and not hamper the railway company with it. Mr. PARSONS advocates the subway in strong terms; and the essential features of his scheme have Messrs. CHANUTE'S and COOPER'S approval, though the latter would place the subway at one side instead of between the tracks.

Directly connected with the question of the subway is the question as to the best method of building the road through the very fine sand which underlies Broadway below Fourteenth St. Messrs. WILSON and BOGART approve Mr. WORTHEN'S plan of driving a rectangular tunnel through it with a roof about 8 ft. below the surface, using a flat roof shield to support the ground in advance of the heading. The importance of this question is fully recognized by them in giving this approval, Mr. BOGART stating that he considers it the most important of all the engineering problems submitted.

Messrs. PARSONS, CHANUTE and COOPER, however, who favor the provision of a subway, hold also that the proposed plan of tunneling beneath the pipes with a roof shield is an unsafe method; and their criticisms upon this plan in connection with the other engineers' approval thereof are very interesting reading. Mr. CHANUTE approves Mr. PARSONS' plan of excavating from the surface, with suitable arrangements for carrying on the street traffic, while Mr. COOPER advises the use of the Beach shield for that portion of the road driven through the sand. Mr. CHANUTE would also use this system to cross Canal St., where wet ground may be struck, and at some other points.

The above are the most important questions discussed in the engineers' reports; but there are very many other points of great technical interest, on which their opinions are most interesting. They are practically unanimous in recommending the loop system for turning trains at the lower terminal. The avoidance of grade crossings at junction points is strongly urged. A curious difference of opinion is shown as to the advisability of reducing the height over all of the cars to 10 ft., as proposed by Mr. PARSONS. Mr. WILSON says there is not the slightest objection to this Mr. CHANUTE thinks it would be well to add on 6 ins; and Mr. COOPER thinks it advisable to be cautious in adopting a low truck. Mr. COOPER differs from all the others in his plan for constructing the tunnel from Twelfth St. north to Forty-sixth. Over this section he would dip the tunnel downward into the rock, and avoid all interference with the street or the underlying pipes. It should be said, however, that the engineers are generally agreed that the best method of construction for the lines north of Union Square cannot be intelligently decided on until thorough surveys and borings have been made along the line.

At present the problem of constructing the road through the sand which underlies Broadway below Fourteenth St., is the one which takes precedence of all others in importance, and a wise choice of methods here is generally admitted to be essential to success.

Whether the roof-shield plan of Mr. WORTHEN is a safe and practicable one or not, in the fine sand found there, the fact that it has been condemned by three engineers of the standing of Messrs. PARSONS, CHANUTE and COOPER, would seem to make it practically impossible of adoption. For it is to be remembered that this road is to be built and operated by a corporation whose stock is yet to be subscribed. The securing of the necessary capital is not the least of the problems before the Commission; and it would be sadly handicapped if it went before the investing public with a plan of construction condemned as unsafe by three leading engineers. Moreover, the chances of organized opposition on the part of property owners along the line will be much increased if there is any doubt as to the safety of foundations adjacent to the road.

According to the law, the general plan adopted by the Commission must contain such details as to manner of construction as may be necessary to show the extent to which the streets and avenues through which the line passes and the property abutting on it will be affected. Mr. CHANUTE expresses a sentiment which will meet with general approval when he says that the old and well tried plan of varying the system construction according to the circumstances and difficulties presented at different points is the way to secure the best results. The reports and criticisms of the other engineers express the same fact.

Whether these details are worked out now before the approval of the aldermen and the abutting property holders is obtained, or afterward, as contemplated by the law, it seems evident that more than the mere adoption of a double deck or four-track level system, and more than the mere decision to dispose of the pipes and wires, or let them alone, will have to be decided upon before the public can give or withhold its approval of the so-called "general plan."

Compressed Air Motors for Street Railways in England.

It is stated by *Engineering*, London, that the Birmingham & Midland Tramway Co. proposes to introduce compressed air as a motor, in place of steam, on its lines from Birmingham to Dudley. The system is that of Messrs. Hughes & Lancaster, of Chester, which is in operation at Chester and Birkenhead, England. The cars at Chester climb a grade of 1 in 18 (5.55%) with the greatest ease. There are no hills on the Birmingham & Midland route to equal this. At Birmingham and at the depot at Spon Lane it is proposed to erect a plant for the purpose of compressing the air. This will be carried by a 4-in. pipe along the foot path, and about every 500 yds. there will be a smaller pipe about 2 ins. in diameter to collect the air and fill the reservoir provided on the car-under the seats. The action by which the cars are supplied is very simple. The car will stop for about 2 secs., when a plate will be raised automatically and lowered to the other side, and when it is perpendicular the air will rush into the car, and the plate will then be ready for the next car coming in the opposite direction. The weight of one of the present engines is about 13 tons besides the car. The new car will weigh 6 tons, but will not hold so many passengers as those at present in use. It is proposed to travel at the rate of 9 miles an hour, which can, it is stated, be done without the slightest danger, the time being saved in the number of stoppages.

Legal Decisions of Interest to Engineers.

Farm Crossings.—Where a railroad company acquires a right of way through a farm by condemnation, the owner of the farm has no right to demand that a private crossing be maintained simply on the ground of convenience to him.—N. Y. & N. E. Ry. Co. v. Comstock, Supr. Ct. of Errors of Conn., 22 At. Rep., 510.

Municipal Assessments Against Joint Owners.—Where a city lot is owned by two or more persons whose interests are specific and distinct, an assessment for improvements must be made *pro rata* against each joint owner, and an assessment against one owner for all is not valid, unless specially authorized by statute.—City of New London v. Miller, Supr. Ct. of Errors of Conn., 39 At. Rep., 499.

Flowage Liabilities of a Railway Company.—When the construction of a railway embankment so changes the flowage of either surface or running water as to flow more upon the land of an adjacent owner than it did before the construction of the embankment, although it flowed there before to some extent, then it is an injury for which damages may be recovered. O'Connell v. E. T., Va. & Ga. Ry. Co., Supr. Ct. of Ga., 13 S. W. Rep., 489.

Recovery for Negligent Repair.—Where in an action against a city for personal injuries from the breaking of a plank in a sidewalk it appears that the plank that broke was a new piece 4 ft. long, 4 ins. wide and 2 ins. thick, resting on stringers 4 ft. apart, put there shortly before to repair a rotten place, and that it broke when plaintiff, weighing 175 lbs., stepped on it, the evidence is sufficient to go to the jury on the question of the city's negligence in selecting a defective plank to repair the sidewalk in the manner described. Evidence that it was a common practice to repair sidewalks in this manner is immaterial. It is inadmissible to show that a sound plank of those dimensions and supported by stringers 4 ft. apart will support the weight of two heavy men. Nor is it admissible to prove that cows sometimes passed along the walk, as tending to show that one might have broken the plank. (Moore v. City of Platteville, Sup. Ct. of Wisconsin, 47 N. W. Rep., 1055.)

Rule of Municipal Liability for Defective Sidewalks.—Where a city is sued for injuries resulting from a defect in a sidewalk, it must appear either that the city had notice of the defect or that it was a patent defect and had continued so long that notice might reasonably be inferred, or that the defect was one which, with reasonable and proper care, should have been ascertained and remedied. An incorporated city which negligently leaves one of its sidewalks out of repair, by reason whereof a person, without fault or negligence on his part, is injured, is liable to such party in damages for the injuries so sustained. If a city carelessly and negligently permits defects to exist in one of its sidewalks, no matter how caused, after notice thereof to the city, or for so long a time that notice is presumable, then it becomes liable if a person is injured thereby without fault or negligence on his part.—City of Kansas City v. Bradbury, Sup. Ct. of Court of Kansas, 25 Pac. Rep., 889.

CORRESPONDENCE.

Railway Surveys.

SOMERSET, Penn., Oct. 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have read with much interest Mr. PAUL'S contribution to your columns entitled "Railway Surveys and Resurveys," wherein he has given a very complete system for compiling and preserving the information that should be in the possession of every railway company. I would like, however, to indicate a way whereby the same information may be recorded for new lines during the period of construction with a very little extra trouble and expense.

In the first place, at the beginning of construction the center line should be carefully retraced with a view to eliminating any errors that might have been made in the location, which should then be sufficiently accurate to form the basis of a series of maps platted on sheets in the same way as proposed by Mr. PAUL. At the same time the levels should be checked and reduced to a common datum, if necessary. Both of these operations will amply repay the labor of doing them, from the amount of trouble they will save afterward during construction, aside from their use in the matter we are now considering.

On the center line, as retraced, should be relocated, if necessary, all intersecting and adjacent land lines, streets, roads, township and county lines, other civil boundaries, buildings, etc., etc. These, together with the right of way, should be put on the maps as soon as obtained, giving station and plus, bearings, etc., so that a complete record of all this information is preserved. As soon as each piece of right of way is secured an abstract of the deed or condemnation is placed on the map.

When the track-centers are run in, if the alignment differs from the original center line, by reason of revisions or errors, sufficient connections should be taken and noted on the map, so that the new line can be platted also. The errors in the original line, even in the roughest country, should be so small that there will be no trouble in putting the new line on the maps. If, however, occasionally larger errors are found, new maps must be prepared, showing the original line as well, as upon it the right of way was taken, and it is important to have a record of it preserved.

At the same time that the track-centers are run in mile-post stakes are set on the side of the roadbed, sufficiently substantial to be preserved until the permanent posts are put in, and the location of each recorded on the maps. Stakes for the headblocks of permanent sidings are also set at the same time and where they will not be disturbed by the track-layers (the headblock will not come exactly where staked, as the frog will be placed at the nearest rail-joint, and they must both be located after the track is laid). In the same way, all bridges, culverts, trestles, tunnels and such company structures as are under way, such as stations, tanks, turntables, etc., etc., are located and recorded on the maps, so that when the road is turned over by the construction department they form a complete record of the property of the company at that time.

It is then a very simple matter to keep them up to date by merely requiring that all future surveys or improvements shall be located from one or more of those points already on the maps, so that all new tracks, buildings, etc., may be placed thereon as soon as completed.

These maps can be got up with a very trifling, if any, extra expense, as all of the field work is done by the resident engineers, and the mapping can be done by the draftsmen usually attached to the engineering staff during construction, or at the most it will not require the employment of more than one or two extra men for this purpose. There should also be prepared a profile of the line, on which, besides the information usually shown, should be noted all bench marks, including the heights of bridge seats, and any other points available for that purpose (if the telegraph line is carried forward immediately behind the track-laying, spikes driven into the nearest poles to the mile-posts, as suggested by MR. PAUL, could be used). An additional advantage that these maps have is that they are connected with the original cross-sections, and the latter can be used in estimating the grading required for any future improvements.

JOHN MARSTON, JR.

BLUEFIELD, W. VA., Sept. 29, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have been much pleased with MR. PAUL'S late articles in your paper on "Railway Surveys and Resurveys," in which he has given a very complete and correct account of the work of which I had the general direction.

I wish, by way of emphasis, to call particular attention to the main features that should be incorporated into every survey of a similar character.

1. Permanent references of stone or iron for lineal and vertical measurements.

2. Duplicate field notes, and thorough office work, with a full drafting staff.

3. The obtaining of full and accurate copies of all county records pertaining to the road and adjacent property.

4. Checking all deeds or titles to property by reference to the original instruments.

5. Binding of maps on flexible stubs longitudinally or on the long edge, and having duplicates made of each volume by photographic reduction or tracing.

I wish to say in conclusion, that there is an "accurate sea level datum" at every railway crossing and in every town in Ohio, Indiana and Illinois, touched by the Lake Erie & Western main line or their Indianapolis & Michigan City Division, carefully checked by accurate instrument work and numerous comparisons. Yours truly.

G. WHITEFIELD CHANCE, C. E.; N. & W. R. R.

The Percentage Method of Performing Difficult Work.

CHICAGO, Oct. 1, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The construction of a cable railway may be something of a novelty to residents of New York City, but to us of the "wild and woolly west" it is an old story. The New York road, as shown in your illustrated article of Aug. 22, has a remarkably heavy rail, and probably Broadway is about as crowded with pipes, conduits and other underground ways as any street in this country. Changing and reconstructing these underground pipes in order to make a clear passageway for the cable conduit, is always an expensive item in the cost of constructing a cable way in any large city, but this difficulty is intensified in the case of the Broadway road.

Your description says "it is intended that two distinct cables will be carried in this conduit, one being held in reserve in case of accident." The first cable road in Kansas City, the Ninth St. line, had that arrangement when it was opened in 1885. A few months later, when they attempted to use the reserve cable, it was found to be chafed in innumerable places to such an extent as to be worthless for hauling cars. It is doubtful if two cables can exist peaceably in the same conduit.

In another paragraph you say "we understood the contractor furnishes his force, wide experience and personality at a certain percentage on the absolute cost of construction, a proceeding unusual, but wise, in this case."

The method of letting contracts for a percentage of the actual cost has been frequently used on railway construction and on buildings. Some of the largest buildings now in course of construction in Chicago are contracted for in this way. As you say of the Broadway cable contract, it is a very good way to do work in many cases. Wherever there is an element of uncertainty as to the difficulties to be encountered, which sometimes develop to such an extent as to require radical changes in the original plans, or where the plans have not been sufficiently completed to indicate all the details of construction and it is desirable to start the work at once in order to gain time, it is good business management to employ an energetic and experienced contractor on a percentage.

Unfortunately, it would be impossible to make such contracts for public works, under the control of municipal bodies, without opening the way for charges of favoritism and "boodling" against those in charge of the work. But the percentage method has many advantages.

The owner is assured from the start that the work will be well done, because the chief temptation for slighting the work has been removed. He is also assured that labor and material bills will be paid and that there will be no liens against the completed structure. He is at liberty to make various changes in the work while under progress, without first obtaining the consent of the contractor, and he is enabled to put a reliable contractor at work on the job as soon as the principal features are determined on, without waiting for all detail plans to be completed.

If there is any uncertainty about the nature of the obstacles to be encountered, the extent of possible difficulties and delays, or the details of construction, no contractor of experience will make a bid on the work without allowing liberally for contingencies. In this way the owner has to pay a large sum for the risk assumed by the contractor, and he might as well take some of those risks himself. Again, in a complicated piece of work some bidder may carelessly omit or overlook some expensive items in making up his estimate of cost, and thus get the work awarded to him at less than the actual cost. It is better for the owner to pay what a job is actually worth, for when a contractor is losing money, either from his own mistakes of omission in making up his bid, or from difficulties that could hardly have been anticipated, it is but human nature for him to endeavor to get even in some way, and the character of the work will suffer despite great care and watchfulness on the part of the engineer. And it is difficult for the average engineer, when he sees a contractor bravely struggling with an unprofitable job, to harden his heart to such an extent as to require all the nicety of construction that he would exact if he knew the contractor was making money on the work.

With the percentage method the owner is at liberty to make the work as costly or as cheap as he pleases. He should have his own trusted employee to supervise the accounts, and should be careful to select the right contractor. There are plenty of honorable and capable men among contractors, who would work faithfully for the interests of their employers if given a contract on the percentage basis.

"ATOM."

House Drainage.

MINNEAPOLIS, Oct. 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: My attention has been called to Mr. JOHN S. HODGSON'S communication published in your issue of Sept. 26, referring to my paper on house drainage, which you did me the honor to reprint from the *N. W. Architect and Building Budget*.

I am glad to find that Mr. HODGSON and I agree as to the "running trap" and "fresh air inlet," the cowl and other points.

As to disconnecting fixtures within the house, I would not think of doing it unless the waste pipe necessary to reach the trap into which it empties is short. Nor would I in general waste a basin, for instance, into such a form of closet as would be fouled by the soapy water. In the cuts I showed a "wash out" closet, adjoining which is a basin, the waste pipe of which, ¾ in. diameter, discharges *into the trap* of the closet. This waste pipe contains less interior surface than is exposed to fouling between trap and basin in many of our expensive basins in common use.

By reason of its small diameter it is well scoured by the discharges, and can be easily scalded or wiped out from end to end. The sewer air will never pass through it; it makes no hole in our floor; it saves $5 or so wherewith to buy a better fixture; it cuts off bills for repairs, and we have no unsightly pipes in connection with it.

This idea of "disconnection" is used by me *wherever it is available as good plumbing*, but never for the sake of the idea.

Whether or not the English practice of disconnecting outside the house, of which I have long been aware, suggested this application I do not remember, but certainly the English practice would be impossible in the colder parts of our country.

Mr. HODGSON betrays a weakness for the "air-pipe" (under conditions which he does not name) as a protection to trap seals.

"By Adam's fall
We sinned all."

is no more orthodox, but even this doctrine is now questioned they say.

Testimony has for years been abundant and everywhere accessible, showing that these air pipes are soon plugged by the soap and grease of basins and sinks, and often by closet wastes. From the moment of this discovery the use of these air pipes should have been out of the question with sanitarians of scientific habit of thought and practice. When we add to the indictment their aid in evaporating trap water, their not being flushed with water, so that leaks in them are only discovered by accident, their cost and general unsightliness, the fact of their survival to the present time is no credit to modern sanitary practice.

As to deep trap seals, I will admit the inconsistency of advocating seals of 4 ins. or greater depth while illustrating a form of closet which can not be found in the market with more than a seal of 2 ins. or 2½ ins. With a soil pipe properly placed as to its ventilating extension, and with a short fall from all traps to the soil pipe, I think 2½ in. seals sufficient.

I use seals of 4 ins. or more, because these conditions do not often exist: nor have I ever known of any trouble from the deep seals, provided they were of bore proportioned to the water supply.

In my own house are traps with seals of 5 ins. or greater depth which have been used for six years without trouble. Some of the patented forms of traps have deeper seals than Mr. HODGSON'S limit, and they give no trouble. I have used the "Sanitas," the "Puro" and others. They help to overcome official objections to good plumbing, and are often easier to obtain than good, deep-sealed traps, without any bad result whatever.

Were MR. HODGSON to carefully test the action of a basin and its waste, (falling to the floor as it usually does before reaching the larger pipe) under the conditions common to plumbing, I think he would favor a deep seal, provided no harm came from using it. Whether or not the use of deep seals has bad after results is a question which I am obliged to settle in my practice by my experience, rather than by "authority." I am built that way.

From an architect's standpoint a pipe is not a decorative feature, however it may seem to the plumber. Our ambition is satisfied when we have found places for such pipes as are necessary about a building, and we don't want to have floors, etc., cut to make way for such as are useless. We can always find good use for a client's money not wasted on such redundancies.

FREDERIC G. CORSER, Architect.

Correction.—In MR. HODGSON'S letter on "House Drainage," in ENGINEERING NEWS of Sept. 26, in the bottom line of third column, page 289, for "independence" read "interdependence."—ED. ENG. NEWS.

English and American Railways.

ATHERTON, Eng., Sept. 26, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: It is my intention to give a paper before the Institute of Civil Engineers (Manchester center) on the American railways as compared with the European railways, and should be glad if you could refer me to a few railroad engineers (chief) who would furnish me with a number of photos showing the general topography of the country through which their railroad passes. R.

While we are always disposed to oblige correspondents as far as possible, it does not seem quite within our province to select railways for comparison with foreign railways upon such a vague explanation as is given in the above letter. If our correspondent's paper is to compare the topography of America with that of Europe and then compare the location of railways on the two continents, he has undertaken a task that is probably larger than he can manage satisfactorily, and one in which the mere study of photographs will be of little use. In a country so vast as this, there is almost every variety of topographical conditions, with railway location good, bad and indifferent, but unless our correspondent understands all these varying conditions his comparisons are not likely to be of much value. It would seem from the above letter that the paper is to be composed from information furnished, as far as American railways at least are concerned, and not from personal knowledge of the subject. This is a very reprehensible method of procedure, as we have pointed out in our editorial columns.—ED. ENG. NEWS.]

American Cars for the Southeastern Railway, England.

(WITH INSET.)

In the several articles upon English railways which were published in the first volume of this year, and in the editorial article upon "English and American Railways," in our issue of July 4, we have described and commented upon the English system of passenger rolling stock, and have compared that system with the American system, pointing out the advantages and disadvantages of both systems. The English system consists of cars varying in length from 26 to 34 ft., with four or six wheels and rigid wheel base, and 46 to 56 ft., with four-wheel or six-wheel trucks (ENGINEERING NEWS, Sept. 26), having the bodies divided by transverse partitions into separate compartments about 6 ft. 6 ins. wide between partitions, with two seats, the passengers sitting face to face. The cars are divided into from four to eight compartments, and the compartments accommodate 6 to 8 first or second class, or 8 to 10 second or third class passengers. For private parties saloon cars, which are generally carried on four or six wheels, can be hired. The introduction of the American system of running gear, with trucks or "bogies" instead of rigid wheel base, led to the use of longer cars, and made the cars much more comfortable and easy riding. There is one valid reason for the use of short cars on English railways, and that is that the public appreciates the convenience of through cars; and while there may be sufficient passengers to fill a short car there are not enough to fill a long "bogie" car for each place. Some trains running out of London, for instance, have through cars for 8 or 10 destinations, on various parts of the system or on branch and connecting lines. With the development of passenger traffic, saloon cars for general use; sleeping, drawing-room and dining cars, and cars with lavatory accommodations for passengers holding first-class tickets. There is generally only one of these cars in a train, although the London, Brighton & South Coast Ry. has a solid vestibuled Pullman train. The London & Northwestern Ry., which has adopted the policy of making all its own material and equipment, has saloon, drawing-room, dining and sleeping cars which were built at its own works to the designs of its officers. The Great Northern Ry. has also some saloon cars of the Mann type. The introduction of special cars of this kind has naturally led to a certain amount of rivalry between different roads, and consequently to a continued increase in the use of such cars.

INTERIOR OF DRAWING-ROOM CAR; SOUTHEASTERN RAILWAY, ENGLAND.

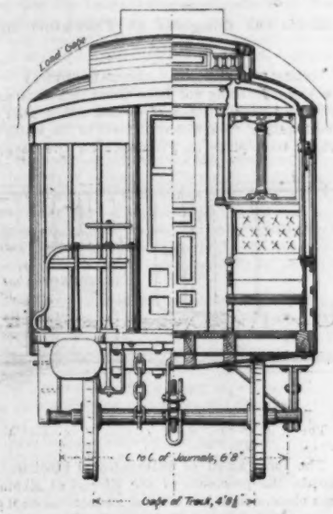
DRAWING-ROOM CAR; SOUTHEASTERN RAILWAY, ENGLAND. Gilbert Car Mfg. Co., Troy, N. Y., Builders.

(The trucks are shown fitted with 33-inch American wheels, but the railway company will fit them with its standard 42-inch wheels.)

The Southeastern Ry. has for a few years been running what is called a "club train" between London and Dover, in connection with its channel steamboat service and the continental railway service to Paris, etc. This train has been regarded as a very elaborate affair, and a very high extra fare has been charged for the privilege of traveling upon it, a much higher fare in fact than the accommodation appears to warrant. The train consists of some cars of the continental or "American" pattern, being somewhat similar to the old fashioned style built in this country several years ago, and having through communication and vestibuled con-

Some years ago the Midland Railway, which is one of the most progressive of the English roads, and which was one of the first to adopt the American running gear for its cars, and to abolish the second class of passenger traffic, introduced some Pullman drawing-room cars for its express service. The Pullman Palace Car Co. states that there are now 19 of these cars in England, including 12 sleeping cars and 7 parlor cars, on the Midland, Great Northern, Highland, London & Southwestern and London, Brighton & South Coast railways. On most of these lines an extra fare above first-class fare is charged for the use of the Pullman cars, but on the Midland Ry. they are available

nections between the cars. The train is not always made up of the same cars, but a correspondent sends us the following description of its make-up on a recent date: "The engine was of the eight-wheel type, and the cars were of the 'Compagnie Internationale des Wagon-lits et des Grands Exprés Européen,'



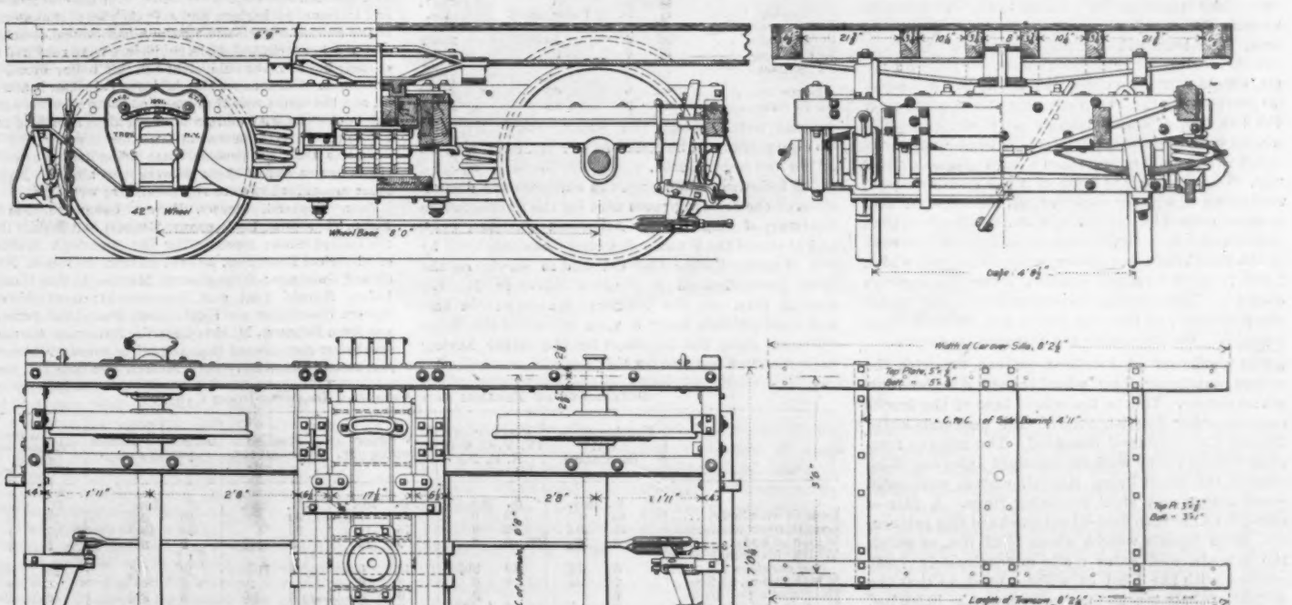
Cross-Section of Buffet Car; Southeastern Ry., England.

painted a dark green. The train consisted of four cars; next to the engine was a combination baggage and smoking car, then two passenger cars, and an ordinary Southeastern Ry. brake van or conductor's car at the rear. The first three cars were vestibuled. The cars had low roofs. Each of the passenger cars had a boudoir or stateroom at one end, with a passage at the side; five tables (with seats on each side) on each side of the central aisle in the main saloon, and a closet and lavatory at the other end. On one car was painted 'Brake; Westinghouse and vacuum automatic; weight, max., 3,800.'"

The eastbound "club train" leaves London at 3 P. M. and arrives at Dover at 4:45 P. M. The westbound train leaves Dover at 9:15 P. M. and arrives at London at 11 P. M. The run of 75½ miles is made in 1 h. 45 min. without a stop, the average running time being a little over 43 miles per hour. The single fare on the club train is 25 shillings ($6.20), including an extra fare of $1.20 charged to passengers who travel between London and Dover only and do not cross the channel. The single fare from New York to Albany, 143 miles, on the New York Central & Hudson River R. R., is $3.10, with a charge of $1 for a seat in a drawing-room car, so that for $4.10 a passenger can travel that distance on the Chicago Limited, which is composed exclusively of palace drawing-room, sleeping and dining cars. The distance between New York and Philadelphia by the Pennsylvania R. R. is 90¼ miles, and the ordinary fare is $2.50, with an extra charge of 50 cts. for a seat in a parlor car, or $1 on the "limited" trains. The Chicago limited on the New York Central R. R. makes the run of 143 miles from New York to Albany in 3 h. 18 mins., or at the average rate of 43.3 miles per hour. The Chicago limited on the Pennsylvania R. R. makes the run of 90¼ miles from New York (Jersey City station) to Philadelphia in 1 h. 59 mins., or at the average rate of 45.6 miles per hour.

It will be seen from the above that the company makes a particular speciality of its continental express service, its object being to attract the large traffic of wealthy people and tourists between England and the continent, and its latest move has been to order an entire train of American cars from the Gilbert Car Mfg. Co., of Troy, N. Y. The drawings of these cars are given on our inset sheet, and we also give some views of the interior. The cars are very handsome specimens of work. As stated in an editorial note in our issue of Sept. 26, the cars are lower and narrower than those of American roads, owing to the smaller dimensions of bridges, tunnels, etc., and therefore the interior loses somewhat of the handsome effect of our wide and lofty cars. The cars here described have been made as large as possible, as will be seen by the cross section of the buffet car and loading gage. In fact, since the construction of the cars was commenced the upper edges of the monitor roof have been rounded off to provide more clearance.

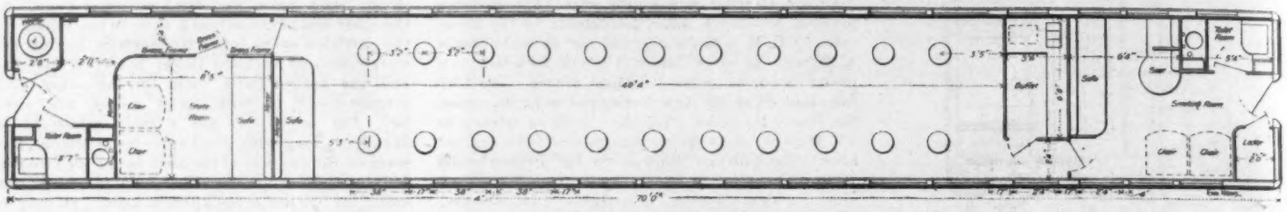
The cars are six in number, and form a complete train, including one baggage car, one buffet car and four drawing-room cars. The general construction and arrangement are in accordance with standard American practice, as shown by the drawings. The leading dimensions and other particulars are given in the accompanying table. The drawing-room cars have a main saloon 29 ft. 10 ins. long, with 14 revolving chairs and 3 fixed seats against the partitions. At one end a door in the side of the partition opens into a smoking room, 10 ft. 10 ins. long, fitted with fixed seats on one side, and 3 moveable chairs. The corner of the smoking room is inclosed to form a toilet room about 2 ft. 4 ins. by 3 ft 9 ins. inside dimensions. This room is fitted with closet, wash basin and drinking-water tank. At the other end of the saloon a door in the middle of the partition opens into a passageway, having the store-room and inclosed Baker heater on one side, and the ladies' toilet room on the other. The arrangements of both toilet rooms are similar. The buffet car has a main saloon about 33 ft. 3 ins. long with fixed seats for 28 persons, the seats on the one side of the aisle being for two persons and those on the other side for one person each. At one end is the kitchen, about 5 ft. long by 5 ft. 6 ins. wide inside, and having a locker and refrigerator to fill the space on one side of the door. An oil stove, made by the Adams & Westlake Mfg. Co., of Chicago, Ill., is used. The opening above the pay counter has a bronze grating. At the other end of the saloon is a passage with the heater and store-room on the one side and toilet room in the other, as on the drawing-room cars. The baggage car is open throughout, having no partitions, and the interior finish is of Norway pine, not painted, but coated with shellac.



DETAILS OF TRUCK FOR THE AMERICAN CARS FOR THE SOUTHEASTERN RY., ENGLAND.

The interior finish of the drawing room and buffet cars is of antique quartered oak, with antique (pale yellow tint) bronze fittings and baggage racks. The ceiling is of three-ply quartered oak veneer, handsomely decorated. The buffet car is upholstered in embossed leather. The drawing room cars are upholstered in "frisé" plush, two in blue and two in old gold. The window hangings are of silk to correspond. The floors will be carpeted. The windows have balanced sashes, which will stay at any desired position without the aid of latches, and bronze rods are placed outside to prevent passengers putting their heads out, on account of the small clearance. Spring roller blinds are fitted to all windows; blinds rolling upward, are used for the windows of the toilet rooms. The exceptionally cold and severe weather of last winter added so much to the discomforts and dangers of traveling in cars unprovided with heating arrangements, which is the

ordinary plan in England, and aroused public opinion to such an extent, that the Southeastern Ry. Co. has wisely adopted a heating system in these cars, which will therefore be well appreciated in winter service. A Baker heater of the "Mighty Midget" class, manufactured by the Baker Heater Co., of New York, is fitted to each drawing-room car, and the water pipes are led along the sides of the car just above the floor. The cars will be fitted with incandescent electric lights, on the storage battery system, the batteries being carried in a case beneath the floor, necessitating the novel arrangement of truss rods shown on the drawings. It is said that the lights will not all be placed in the clear-



PLAN OF WAGNER PALACE PARLOR CAR; N. Y. C. & H. R. R. R.

story, but the majority of them at the sides for the roof, above the seats. Hand brakes are fitted to the cars by the builders, but the railway company will equip them with the continuous vacuum automatic brake used on this and other English roads. The platforms have side steps, but placed vertically, forming a ladder, as the high platforms at stations prevent their projecting like the steps of American cars. This leaves the car platform the full width of the car, instead of being cut away at the sides for the steps as in American cars. As the station platforms are level with the car floors, these steps are only for the use of employees, as at yards, etc. The platform rails are nickel-plated. Spring buffers are fitted at the ends in accordance with English practice. The couplings also are of the English pattern, consisting of a chain attached to one drawbar and hooked over the end of the other drawbar, then drawn tight by a right-and-left hand screw by means of the weighted lever shown in the drawings, which lever is in a vertical position when the cars are coupled. The coupling-hooks are placed well under the platforms, so that the latter are brought close together. Safety chains are also used, as shown.

The trucks are of American pattern, but with the rather unusually long wheel base of 8 ft. for four-wheel trucks. This is the wheel base of the trucks on some other English roads. The pedestals are of Master Car Builders' standard. The railway company will fit them with its standard axles and 42-in. wheels, the latter being Mansell wheels with solid wood filling and steel retaining rings. A pair of standard American four-wheel trucks of this pattern, with 33-in. wheels weighs about 17,400 lbs., of which the wheels and axles make approximately 7,000, varying with the kind of wheels used, so that the weight of these trucks may be assumed as 10,500 lbs. exclusive of wheels and axles. The trucks have steel brakebeams, with adjusters for taking up the wear of the shoes, the adjusters being similar to those used on the New York elevated railways. The brake-shoes are compound, made of two metals, one cast into the other. In the view of the exterior elevation the trucks are shown fitted with 33-in. American wheels and temporary wooden brake shoes, as the English 42-in. wheels will be fitted by the company.

The cars are made in sections for shipment, clearly and systematically marked so that they can be erected at the railway company's works, which are at Ashford, Kent. The painting is all done in this country, and only a little touching up at the joints, and perhaps a final coat of varnish, will be required after erection. The outside color of the body is a very dark lake, almost a bright chocolate color, with gold letters and striping, shaded in red. The trucks are painted a sage green tint, harmonizing with the color of the body.

The train will probably be hauled by one of the fine modern engines of the eight-wheel type, illustrated in our issue of Feb. 22, 1890, which are fitted with the vacuum automatic brake, and not the Westinghouse brake as there stated. It is likely that two drawing-room cars will be sufficient for the "club train," and that the others will be run singly on some of the regular express trains.

Mr. WM. WAINWRIGHT, Car Superintendent of the Southeastern Ry., states that the company's standard cars are carried on six wheels, and are fitted with vacuum brakes and gas lighting. There are no standard four-wheel cars. The short, close, coupled cars for local trains, mentioned in ENGINEERING NEWS, May 23, are modifications of old cars, which had formerly long buffers, and have been altered for the suburban traffic. The newest cars that were built for suburban traffic are the close coupled "bogie" cars on four-wheel trucks, and are also fitted with vacuum brakes and gas lighting. The particulars of the standard six-wheel cars and suburban cars on trucks are as follows:

ORDINARY CARS OF SOUTHEASTERN RAILWAY.

	Length, ft.	ins.	Number of Passengers.	Weight empty, lbs.
Six-wheel Cars.				
First-class	30	0	24	28,876
Second-class	33	0	40	29,568
Third-class	34	6	60	29,120
Cars on Trucks.				
First class	40	6	48	44,632
Second- lass	43	0	60	41,496
Third class	43	0	80	40,264

Some notes about the Southeastern Ry. and its equipment will be found in our issues of May 23, July 4 and Sept. 5, 1891.

The following table gives the comparative dimensions of the drawing-room cars for the Southeastern Railway, of English and American Pullman cars, and of one of the Wagner drawing-room cars built by the Wagner Palace Car Co., and in service on the New York Central & Hudson River R. R. We give a plan of the Wagner drawing-room car, and shall publish later a plan of one of the large Pullman cars, the drawings for the latter having been received too late for this issue.

DIMENSIONS OF ENGLISH AND AMERICAN DRAWING-ROOM CARS.

	Southeastern Ry. (England.)	Wagner car (N. Y. C. & H. R. R. R.)	Wagner sleeping car.	English Pullman car.	Largest Pullman parlor car.	[5] Largest Pullman car built.
	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.
Length over body	45 0	70 0	70 7½	52 0	60 6	70 0
Length over platforms	51 3½	76 0	76 11½	59 4	76 10	77 4
Width of body	8 3¾	9 8	9 10	8 8¼	9 8	9 8
Width (extreme) over roof cornices	8 4¾	10 0⅛	10 0⅛	8 11	10 0⅛	10 0⅛
Width inside, at floor	7 3¾	9 0	9 0	.. ....	9 0	9 0
Height at side, inside	6 4	6 9	6 8⅛	6 3½	6 8⅛	6 8½
Height at middle, inside	8 5	9 5⅝	9 5⅝	.. ....	.. ....	.. ....
Height from rail to top of roof	12 9	[2] 13 11½	13 11½	13 0	14 4	14 4
Truck-wheels; number	8	12	12	8	[6] 12	[6] 12
Truck-wheels; diameter	3 6	3 0	3 0	.. ....	3 2	3 2
Truck wheel-base	8 0	10 6	10 6	.. ....	10 6	10 6
Distance c. to c. of trucks	31 4¾	54 6	.. ....	.. ....	53 2	53 8
Weight of two trucks	[1] about 8½ tons.	33,250 lbs.	33,250 lbs.	.. ....	31,000 lbs.	.. ....
Weight, total	about 22 or 23 tons.	94,950 "	102,000 "	.. ....	92,000 "	95,000 lbs.
Seating capacity	[3] A, 24; B, 28	[4] 40	32	.. ....	36	30 berths.
Heating	Baker heaters	Leland ste'm and Baker heaters.	Baker heater, Leland system.	Baker heaters.	Hot water circulation heated by steam and Baker heater.	
Lighting	Electric.	Pintsch gas.	Pintsch gas.	Oil lamps.	Gas.	Gas and electricity.
Brakes	Vacuum automatic.	Westing-house air.	Westinghouse air.	Railway's Std. (Westinghouse).	Westinghouse automatic triple.	

[1] Exclusive of wheels and axles for the English cars.
[2] A, Drawing-room cars; B, Buffet car.
[3] To top of lamp guards, 14 ft. 3½ ins.
[4] In chairs, 22; on settees, 4; in stateroom, 6; in smoking room, 8; total, 40. A similar car but older, and without smoking room, seats 41, as follows: 31 in chairs, 3 on settees and 7 in stateroom. This latter car has 9 lamps, 1 at each end near the door, 1 in the stateroom and 6 in the main saloon.
[5] Sleeping car; 12 sections and 2 drawing-rooms.
[6] Paper center wheels.

The largest Wagner car is Dr. WEBB'S private car *Ellsmere*: Length of body, 72 ft.; length over platforms, 78 ft. 11½ ins.; width of body, 9 ft. 8 ins.; width at eaves, 10 ft. 0½ in.; height from rail to top of roof, 13 ft. 8⅝ ins., and to top of lamp jack, 14 ft. 3 ins.; length of side posts, 6 ft. 6 ins.; each truck has 6 Krupp steel wheels, 42 ins. diameter. Weight of body, 77,750 lbs.; of trucks, 33,250 lbs.; total, 111,000. The car is fitted with Baker heater, Leland steam heating system; Pintsch gas lighting (2 gas tanks), and oil lamps; hot and cold water, bath and electric bells.

The Electrical Congress at Frankfort on the Main.

(FROM OUR EUROPEAN CORRESPONDENT.)

There have probably not been many scientific assemblies where a larger number of distinguished men have gathered together from different parts of the world than that which took place at Frankfort on the Main last week. The long-talked of International Electrical Congress within the precincts of the Electrical Exhibition has taken place, and it has been of an international character in the fullest sense of the word. Commencing on Monday, the 7th September, the work of the Congress only terminated on Saturday last, the 12th September. The proceedings were distributed over general meetings and sectional gatherings, and as in the case of the assembly of the British Association for the Advancement of Science and of other technical societies, papers were read and discussed; but as is the rule, although this policy should not obtain, no decisions on the subjects raised were arrived at, and the result was that many of those who were present went away with more conflicting ideas than held good before their arrival in the old Frankfort town.

No less than 800 persons, some being ladies, attended the Congress, and of these 198 were from abroad. Among those recognized by your representative were:

From England, Messrs. Preece, Crompton, Forbes, Kapp, Thompson, Reckenzaun, Bennett and Maier; from the United States, representing the American Institute of Electrical Engineers, Messrs. Hering, Heinrich, Nichols and Gutmann; from Austria, Messrs. A. Von Waltenhofen, Kareis, Deri and Zipernowski; from France, Messrs. Hospitalier and Korda; from Italy, Prof. Ferraris and from Belgium, M. Eric Gerard. Naturally Germany was better represented than any other country, there being, among numerous others, Messrs. Von Stephan, Heldberg, Grawinkel, Werner von Siemens, Uppenhorn (*Elektro-technische Zeitschirft*) and Kohlrausch. In this brief and hastily written résumé of a week's work it will be of course impossible to give more than an outline of proceedings which will be fully reported in the official account.

A preliminary welcome was given to the visitors on Monday the 7th inst., by Mr. Hartmann of Frankfort, on behalf

of the Electrical Society of the town and of the Reception Committee in the large restaurant at the Exhibition. On Tuesday morning Herr von Stephan, Secretary to the German Post Office, formally opened the Congress by a lengthy speech. It may be mentioned that he had been elected honorary president of that Congress. The fact that so many had responded to the invitation to the Congress showed, he stated, that the time for holding the assembly was very appropriate. References were then made to the first electrical congress in Paris and to the present applications of electricity, after which Herr von Stephan deal with an important point. This was the large demands upon the coal supply for various purposes. Considering that these were considerable, the question arose as to whether it was not possible, in transforming fuel into electricity, to secure a higher efficiency from the plant and at the same time to reduce the consumption of fuel. This important subject should receive careful consideration, especially as a long time would probably elapse before the direct heat of the sun could be utilized instead of the stored-up heat of the sun, or before "another power could be used as a source of energy." In conclusion, he stated the true value of a congress lay in the exchange of ideas by discussion.

After a few remarks had been made by various gentlemen the officials of the Congress were appointed. Dr. Werner von Siemens was elected president, Messrs. Preece, Hospitalier, Ferraris, Von Waltenhofen and Kohlrausch as vice-presidents. Messrs. Uppenhorn, Heim, Ebert and Hartmann were appointed secretaries of the meeting, and Messrs. Epstein, May, von Nordheim and Lepsius were elected secretaries of the different sections. A special section was constituted to deal with the proposed legislation for the electrical industries.

The first general meeting then commenced by Prof. Kohlrausch, of Hanover, raising a discussion on what was the most suitable course of instruction for electrical engineers. A thorough electrical engineer should, he said, have considerable knowledge of mathematics and drawing, but the most important subject was physics, especially in relation to electricity and magnetism, while a knowledge of chemistry would prove useful. Machine construction was, he said, of secondary importance. Most of the speakers in the discussion which followed differed from the learned professor on the latter point, and as Dr. Werner von Siemens remarked, the best electrical engineers of the past originated from mechanical engineers who having first mastered that branch, subsequently went deeply into electrical matters.

A paper was then read in German by Professor Sylvanus Thompson, of London, on "The New Sphere of Alternating Currents." After dealing with the subject from an historical point of view, the author referred to what had been done by the Lauffen-Frankfort transmission of power by rotary currents. A new field was now being opened up in alternating currents, and in a few years' time pictures would doubtless be electrically transmitted as is the voice at present. There remained yet to be carried out octuple telegraphy, telegraphy and telephony without wire, oceanic telephony, etc. He concluded by stating that the future of electrical science lay in the cultivation of the wave theory of electricity.

Wednesday, the 9th inst., was devoted to sectional meetings, and on Thursday the second general meeting took place. Mr. Lowenherz, of Government Physical-Technical Institute, at Charlottenburg, dealt in a paper on the introduction of a standard screw gage in the electrical and allied industries. In heavy engineering the Whitworth standard had been generally adopted, and in America the Sellers standard had been similarly employed, but until recently there had been no normal thread for small screws. The attempts made in various places to remedy this were based almost entirely upon the metric system, which he said should receive universal adoption.

M. Hospitalier, of Paris, in a paper dealing with notations and symbols of electricity, advocated the universal introduction of valid signs, formulæ and nomenclature in electrical science as existed already in mathematics. New names should be accepted with great caution, but the universal name for new developments, such as the "rotary current," was desirable. In the discussion Mr. Uppenhorn expressed the wish for a unification of the unit of work, horse power meaning a different thing in different countries; whilst Prof. Kohlrausch stated that the kilo watt would soon be adopted as the unit of work. This view was approved by subsequent speakers.

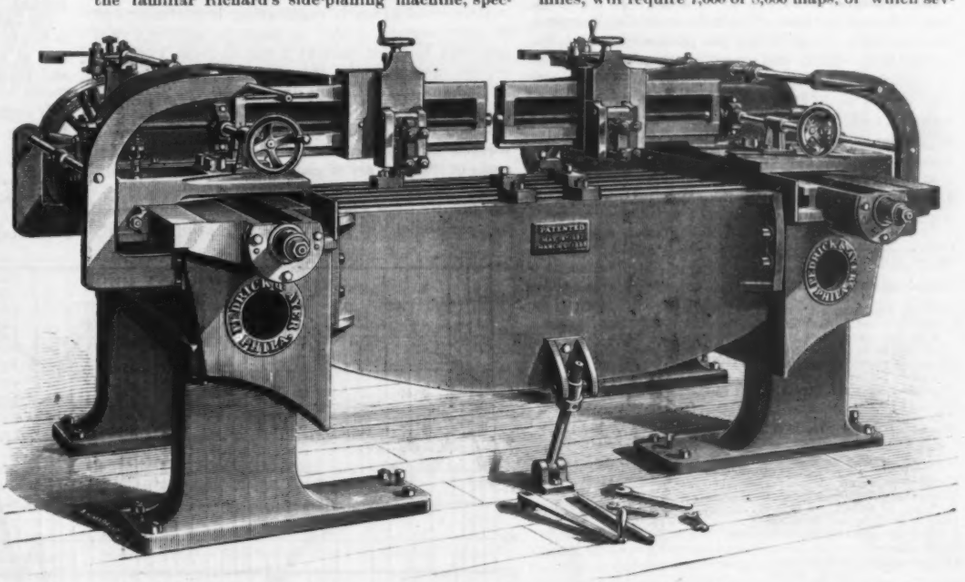
Mr. Oscar May than treated of electrical conductors and fire insurance companies. He was of opinion that it was to the interest of electric light companies to carry out installations efficiently so as to insure safety. One great difficulty was the various rules of different insurance companies, and which differed from each other. He urged that general rules should be adopted, laying down broad principles.

At the third and concluding general meeting held on Saturday last, the 12th inst., reports were received from sectional committees. It was recommended, as regarded symbols, that italic letters should be employed as signs of dimensions; Roman letters as signs of units; and Greek letters for physical constants and angles; that the units Joule and Watt should be universally adopted, and that the units ampère, coulomb, farad, joule, ohm, volt and watt should be represented by their initial letter. No decision was, however, arrived at and the question was postponed to a future occasion, as was also the subject as to the adoption of the "henry."

Mr. Zipernowski described the proposed electric railway between Vienna and Buda Pesth, the details of which are fairly well known. Shortly afterward the congress was declared at an end by Herr von Waltenhofen, who presided on that day. Special subjects were dealt in during the week by five distinct sections sitting simultaneously. During the congress various festivities took place, and on the 14th and 15th inst. excursions were made to Wiesbaden and to the Lauffen generating station.

Duplex Planing Machine for Scarfing Ship Plates.

The cut given herewith shows a modification of the familiar Richard's side-planing machine, specially designed for the use of the Newport News Shipbuilding Co., in scarfing the ends of ship plates applied about the stern-post and bows of vessels. The machine is essentially a combination of two of the open side planers, connected by a platen so arranged as to be adjustable to any desired taper, with the usual smaller platens dispensed with.



DUPLEX PLANING MACHINE FOR SCARFING SHIP PLATES.

The machine is made to handle plates or sheets up to 21 ft. long by 5 ft. wide, and these can be scarfed down at the corners for a space 6 ins. wide and 15 ins. long. The two machines are entirely independent of each other in driving and handling appliances and either one or both can be used as desired. The end supports of the compound machine are connected together by being bolted to heavy iron beams; and the platen, after being adjusted, is also firmly bolted to both. The support for the adjusting screw seen in front, is bolted down to one of the tie-beams, which in the cut is supposed to be under the floor.

The machine is worked from the front with the operator in the usual position. It can be adapted to general work of this class by a few changes in detail and in the form given has proved very efficient and simple in operation. It is built by Pedrick & Ayer, of Philadelphia, Pa.

Geological Map-Making.

At one of the meetings of the late International Congress of Geologists at Washington, D. C., the coloring of geological maps was discussed. Major POWELL exhibited charts illustrating the graphical system used in the Geological Survey of the United States. Experience, he said, has shown that pure colors have but little use; that is, that the color scale cannot be so divided as to show numerous clear distinctions. Physicists who were consulted said that not more than eight or ten divisions of the chromatic scale could be readily distinguished. It was accordingly decided to use conventional patterns as the primary basis of subdivisions, and to repeat the prismatic scale four times. The pattern chosen to indicate the archean rocks is a combination of short line of different colors. The elastic rocks, which include nearly the whole fossiliferous series, are indicated by bars printed in a light background of the same color, and the successive formations are shown by the following scheme: Neocene, orange; eocene, yellow; cretaceous, yellow-green; carboniferous, blue; jurassic, blue-green; devonian, violet; silurian, purple; cambrian, pink; algonquin, red. The pleistocene period is designated by a pattern of dots and circles, and the formations are indicated by colors combined with the patterns. Volcanic rocks are designated by a pattern of dots and circles, and the formations are designated by a pattern of triangles and rhombs. The entire geological survey of the United States, 3,500,000 square miles, will require 7,000 or 8,000 maps, of which several hundred are now ready for publication. The scheme adopted is believed to be so simple that any one can understand it, so that the maps may be widely circulated and understood.

A running fire of comment and criticism ensued in the course of which it was said that the maps of the British Geological survey are colored by hand. Major POWELL then explained the system of lithographing and printing used in the United States, and remarked that it would require the labor of all the inhabitants of Washington to color these maps by hand.

The Viege-Zermatt Railway.

In 1886 the construction of a railway was authorized from Viege, in the valley of the Rhone, in Switzerland, to Zermatt, the famous mountain resort, a distance of 27 miles. This road was financed by Messrs. Masson, Chavannes & Co., of Lausanne, and the Commercial Bank of Bale, and a company was formed with a capital of $500,000 in shares, with authority to raise further funds by guarantee loans.

In 1887-88 Mr. MEYER, engineer of the Jura-Simplon Ry., and later, Mr. AUGUSTE PEREY, were engaged in surveys for this line. Viege lies at an elevation of 2,000 ft. above the Mediterranean, and Zermatt 5,310 ft., making an elevation of 3,220 ft. to be climbed. Various plans were submitted, but later a plan was adopted for a road 22 miles and 1,587 ft. long, with a little over 4 miles horizontal and the remainder of grades varying from 1½ to 4%, there being 10 miles of the latter grade. Further surveys were made, including rack rail sections, with grades up to 10%.

Toward the end of 1888 Messrs. Chapins & Stockalper proposed to build the road with rack-rail grades up to 12%, and a contract was let to that firm. The total length of the line was shortened 1,650 ft. and the length of the tunnel reduced from 3,336 ft. to 786 ft. After a study of the various rack-rail roads in Europe, the Abt system was finally adopted, as the location required the rack-rail sections to be spread over the whole line, with intervals of ordinary rail between. They valued the increased running expenses due to the rack system at 6¾ cts. per train mile.

A profile of the line is given in *Industries*, of Sept. 11, from which we abstract this description: The line rises the whole way, which simplified the construction of the engine and avoided the trouble of keeping the firebox covered with water when running down hill. In passing from the adhesion to the rack-rail a vertical curve was used, with a radius of 3,270 ft.; though at one station, to reduce space, a radius of 2,460 ft. was adopted. The chief bridge was the Muehleback viaduct, which has a length of 176 ft. between pier centers and is 148 ft. above the valley.

The track is laid to the metre gage (3 ft. 3⅜ ins.), and is in a single line. The rails are of the Vignoles or tee section, weigh 49 lbs. per yard, and are 34 ft. 8 ins. long. Each rail rests on 13 mild steel ties, weighing 83 lbs. each. The Abt rack-rail consists of two plates each 1-in. thick for grade of 10% and upward, and ⅝-in. thick for grade between 7 and 10%. The locomotives were built on the "combined" system with four cylinders, and the leading dimensions are given as follows by the builders, the Swiss Locomotive & Engine Works, Winterthur, JULES WEBER, managing director:

	Ft.	Ins.
Gage	3	3⅜
Inside cylinders, diameter	1	2¼
" " stroke	1	5½
Outside cylinder, diameter	1	0⅛
" " stroke	1	5½
Driving and coupled wheels, diampter	2	11 1/16
Trailing wheels, diameter	1	11⅝
Wheel Base:		
Distance between driving and coupled wheels	6	5 3/16
Distance between driving and trailing wheels	7	8⅛
Distance between spur wheels	3	⅜
Diameter of spur wheels	2	3½
Pitch of teeth		4½
Boiler:		
Heating surface, firebox	70 sq. ft.	
" " tubes	635 "	
Total	705 "	
Grate area	12.9 "	
Working pressure per sq. in	170 lbs.	
Number of tubes	166	
Diameter of tubes, externally		1¾ in.
Length of tubes between plates	8 ft.	2⅛ "
Shell plates		7/16 "
Copper plates, tube plates		½ "
" " other plates		5/16 "
Water in the boiler	2 tons.	
" tanks	2½ "	
Contents of coal-box	1 "	
Weight of engine empty	23¾ "	
" " in service	29 "	
Weight of driving and coupled axles, each	10 tons 4 cwt.	
Minimum curve radius on adhesion line (outside of stations)	164 ft.	
Minimum curve on rack line	262½ ft.	

Appended are the specifications for testing the material employed:

Material	Tensile strength in tons per sq. in.	Extension in percentage of length.
Steel used for spur wheels	43¾—47¾	15—20%
" " axles	37	20%
" " tyres	44	15%
Boiler plates, mild steel	24¼—27	20%
Rivet iron and staybolt iron	24¼	20%
Copper for firebox and stays	14¾	35%

The cars are of the American type, carrying a load of 12 tons on double trucks. They are fitted with hand and vacuum brakes, working on the adhesive and cogged wheels. The line was opened to traffic in the summer of 1890 as far as St. Nicholas, and last July was opened for its whole length.

CAR-STOVES ARE COSTLY on the New York, New Haven & Hartford Railway. The State of New York has obtained from Judge Barrett, of the Supreme Court, a verdict against this road for $7,000, as penalties under the act forbidding the use of car-stoves in passenger coaches. The statute provides a penalty of $1,000 for the first offense and $100 for each day the violation of the law continues. The case was before the Court of Appeals, and the defence was that the Company did not have 50 miles of road in the state, and the Baker system of car-heating used by the defendant had been approved by the Connecticut authorities; also that the act was unconstitutional because it bore on inter-state transportation. These pleas were over-ruled.

The Report of the Rapid Transit Commission's Engineers.

Two important and novel engineering problems are now under investigation in New York City by a commission of prominent citizens, whose ability is generally recognized, assisted by a staff of engineers and consulting experts who hold high rank in their profession. These problems are, briefly, the construction of a four track rapid transit railway underneath the city's principal business street, and the disposal of the pipes, wires, etc., now buried beneath the street surface.

By direction of the commission, plans were prepared by Mr. WM. E. WORTHEN, its Chief Engineer, for a four-track road, having all its tracks on a level, and by MR. WM. BARCLAY PARSONS, Principal Assistant Engineer, for a four-track road arranged as a double-deck structure. The plans and reports submitted by these engineers were laid before four consulting engineers, and their criticism was asked upon them. In our editorial columns we have briefly summarized these reports and explained the principal points still under consideration. As the matter is of so much engineering importance, and is quite certain, sooner or later, to become a vital question in other cities as it has in New York, we reprint herewith the substance of the plans submitted and the criticisms upon them. The drawings submitted by Messrs. WORTHEN and PARSONS are not needed for the ready understanding of the designs worked out by each; but we hope to publish such parts of them as are of general interest in an early issue.

While we have somewhat condensed and altered the phraseology of the reports in reprinting them, we have included practically all the recommendations and opinions presented by each engineer, and so far as possible, without adding too much to the length, we have reproduced their exact language.

The reports of Messrs. THEODORE COOPER and Jos. M. WILSON we postpone to our next issue.

REPORT OF WM. E. WORTHEN, *Chief Engineer.*

Broadway Line.—This starts with a single loop track at Battery Park, which comes together to form a double track line just north of Beaver street; thence following the east side of Broadway to City Hall; thence by a four-track line to Spuyten Duyvil, the terminal.

I have become satisfied that a single track, looped, can accommodate all passengers below City Hall in sittings and speed of transit. The loop will admit of a one-minute headway between the trains, and the length of trains and consequent seating capacity is much beyond that of the elevated roads, and can readily be increased.

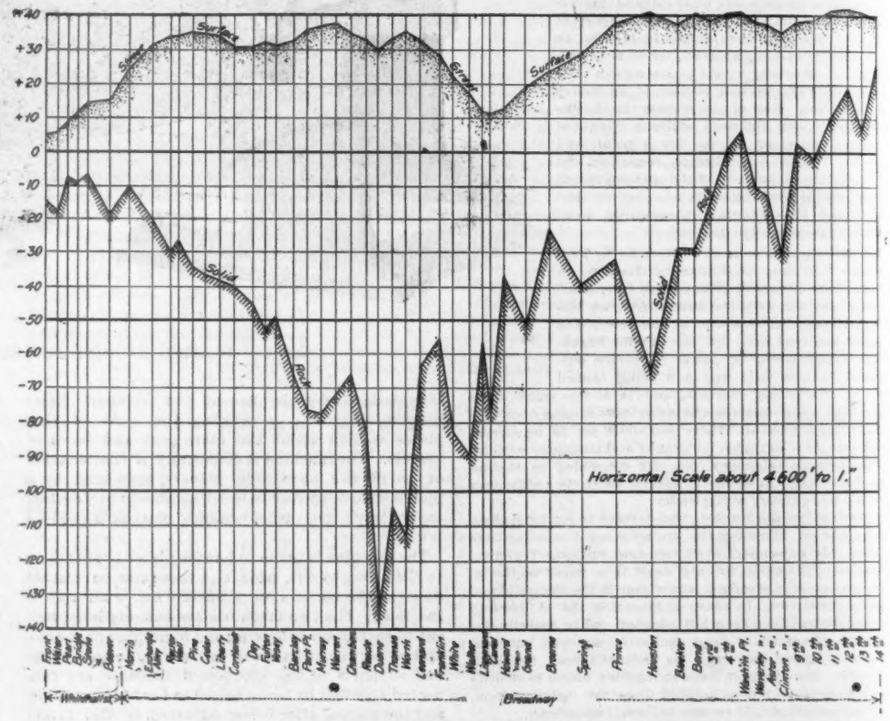
The up track, on the east side of Broadway, is entirely beneath the sidewalk, occupying a portion of the vaults where there are any. On and along Battery Park the same conditions will obtain beneath the sidewalk there; but as no provision is to be made there for passing trains beneath the side streets, the depth below the sidewalk to passenger platform will not exceed 10 ft.

The construction of the four-track road, from City Hall north to Fifty-ninth St., consists essentially of a tight plate iron cover supported by wrought iron girders and posts with a concrete base. Above the plate iron, a preparation of coal tar is to be injected, which not only secures tightness but will preserve the iron. It has been the intention, wherever practicable, to carry on this work without disturbing the surface of the street, leaving intact the present pipes and structures.

The sheave pits of the cable road are 4 ft. below the surface, and 36 ft. between the centers. The water pipes at their outer bottom are generally from 6 to 7 ft. deep, and it is not desirable to move them or the gas pipes, but it is preferable for comfort and safety that they should be kept above the tight iron cover of the railway and not be removed to galleries beneath. Should the present subways, pneumatic tubes or steam pipes give out, space might be obtained for them on the walls or ceilings of the railway.

The sections given show the plate iron of the railway to be 8 ft. below the curb, which (as far as we can ascertain at present) is sufficient to avoid all existing pipes; and this depth gives head-room beneath the sidewalk for access to the central cars over the inside ones, which is only necessary at the united local and express, or transfer stations. The depth of earth cover is reduced in some places.

It has been considered desirable that the excavation should not be below the foundations of present buildings; and as laid out, this is secured, with regard to all new buildings and most of such as may be considered fairly permanent, by the designs herewith submitted.



PROFILE OF BROADWAY, NEW YORK, BELOW FOURTEENTH ST., AND OF ROCK UNDERLYING IT.

It has been considered that there would be trouble in crossing beneath Canal St., on account of the soft material for foundation; but this fear has been dissipated by the soundings; and, on consultation with the sewer department, it is found that all the sewage to the east of Broadway now flowing westerly can be diverted by some new sewers into the East River, with a great improvement to the city sewer system at this point, and simplifying very much the railway construction.

A modification of the standard section is made between 36th and 37th Sts., where the sheave pit of the cable road occupies the center of the street at too great a depth to pass the railway beneath it, and there is space enough on the east side for two tracks and also on the west side by a slight encroachment beneath the sidewalk.

The cross section of the double track line below City Hall is the same at stations and between them. This was

done so that pipes and wires, if thought necessary, might be laid beneath the platform and continue in the same line; but if not necessary, the width might be reduced between stations.

The section of cars is 8 ft. 6 in. wide by 8 ft. high, above platform, outside measurements. As they are to be almost entirely beneath a tight iron cover, it was thought better that there should be no monitor deck to the roof, but that ventilation could be better secured by making a plain roof with windows as high up as possible, which would also give more light and view in open cuts. The length of cars and capacity may be considered the same as those of the present elevated roads, although there will undoubtedly be some modification or entire removal of end platforms with some central openings of great capacity for ingress and egress.

The length of platform as laid out embraces a block and the two side streets at each end of the block, making 320 ft., which will admit of trains of 350 seats; but these platforms can be readily lengthened when the transit comes up to this limit. Three hundred and fifty passengers in trains under one minute headway would give a relief for many years.

Between Thirty-seventh and Fifty-ninth sts., Broadway is 100 ft. wide, with 60 ft. roadway. With this width the platforms of the railway can be placed beneath the roadways. Access to them is given by a staircase on the sidewalk just inside the curb, but it would be preferable to secure some building opposite the center of the station in which all the offices would be placed, with passageways under the sidewalks to the platforms and without any obstruction to the sidewalks.

Fifty-ninth St. to Spuyten Duyvil.—It is proposed to construct this portion of the line by an open cut except when the limit of grade of 1% compels the substitution of tunnels or viaducts.

Along this line there is an opening 16 ft. wide for air and light; this opening is to extend the entire length of the railway except when covered by the station house, by the bridge for cross streets, in tunnels, or on viaducts. A space on each side of this opening is preserved for grass plats, flower beds, shrubbery, in general appearance like those on Park Ave. between Thirty-fourth and Fortieth Sts., except that the opening is to be continuous nearly from street to street. Thirty ft. on each side to be reserved for street and 21 ft. additional for sidewalks, as originally laid out. The bridges on cross streets to be iron girders, tight plate covers and asphalt or granite block pavement. The station houses to be 42 ft. front, occupying the width of opening and the two side grass plats, by 30 ft. in width, and to contain all the offices, waiting and retiring rooms on the level of the street.

For the viaduct across Manhattan Valley a bowstring truss has been adopted as more æsthetic than a plain one. The piers or posts to be of plate iron on a granite base, and set off in equal divisions of two to each block, or in spans of 130 ft. in the usual blocks and streets, and 143½ ft. where the streets are 100 ft. wide. The width is intended to be for three tracks, about 35 ft. in the clear. There is also to be another viaduct at 157th St., which might be similar to that across Manhattan Valley. There is also a viaduct from 193th St. to Spuyten Duyvil, which might be a plain truss, with about the same span as at Manhattan Valley, or the usual construction of the Elevated railroad, short spans with plate girders. There will be tunnel cuts at 154th, 172d and 190th Sts. Up to 150th St. the maximum grade is 1%; beyond this there are two heavier grades, one of 1½% from 150th St. to 174th St., and one of 1½% from 185th St. to near Spuyten Duyvil.

REPORT OF WILLIAM BARCLAY PARSONS, *Principal Assistant Engineer.*

General Description.—There are two general systems by which it seems possible to construct a railway under Broadway without interfering with the pipes and wires; a tunnel in the solid rock reached by elevators, or a tunnel midway between the rock and surface, driven through the sand by a shield.

The borings to rock along Broadway, made by direction of the Commission and shown on the accompanying profile [which we republish from our issue of July 18, 1891] prove that at many points the rock is 100 to 163 ft. beneath the surface. Hence a tunnel in the rock to have solid roof must be at a depth of 200 ft. or more, which makes this plan practically out of the question. As to tunneling through the sand, while I believe it would be possible to drive such a tunnel, I also believe that the cost of doing so would be very excessive, and the risks run very great. The borings show that along a large portion of Broadway, especially where the buildings are the largest, and the traffic greatest, the sand is exceedingly fine, approaching, if it is not actually, a quicksand. In the space above the top of the tunnel are all the water mains and sewers; and if the slightest settlement takes place in the roof of the tunnel (which it would be almost impossible to prevent), a leak in the pipes would be almost inevitable; and as soon as sand should be charged with water the tendency to flow would be greatly increased, and a further settlement would follow. Not only is the weight of the sand above to be considered, but the weight of the enormous buildings along Broadway, which practically amounts to surcharging the soil, and also the street traffic, constantly setting up a jar or trembling of the sand, and so increasing the tendency to run. If an accident should occur, the loss might be so great as to be beyond power of any company or contractor to make good. From Twelfth St. north the shield would have to be driven partly through rock and partly through sand, increasing the cost and danger.

These two systems, which avoid interference with the underground pipes, being imperfect, I have endeavored to devise a structure close to the surface of the street which would deal with the pipe and wire systems in a satisfactory manner.

I propose four tracks set in tiers close to the curb line, the upper track for local, the lower for express service, with the chamber between them large enough to contain all the pipes and wires now located beneath the surface of the street, with those likely to be added in the near future, and with the possibility of further extending this chamber to any desired extent.

Width of Broadway.—Along the whole length of Broadway, as far at least as Twenty-third St., vaults, and in certain cases, subvaults, have been built beneath the sidewalks. It is desirable not to interfere with these, except when absolutely necessary, and I have aimed to keep the railway between curb lines, except at stations, and these I shall locate at street corners and let the platform run across the side street, to reduce the taking of vault space to the minimum.

From Fifty-ninth St. to Thirty-fourth St. the street is 100 ft. wide, with a 60 ft. roadway. Below Thirty-fourth St., Broadway is very irregular, the narrowest place being at Rector St.—34 ft. 4 ins. roadway. At Nineteenth St. the width is 37 ft. 5 ins., and at Twenty-eighth St. it is 39 ft. Fortunately, at Rector St. the pipe chamber can be contracted in width, as the pipes in the street are much reduced in size. From Cedar to Fulton St. there will be 39 ft. between side walls, from Fulton to Canal, a width of 42 ft. can be had, from Canal to above Twenty-fifth St. we can take 44 ft. by slight encroachment on the side walks. Above Twenty-fifth St. a width of 40 ft. can be taken, the pipe gallery being narrowed, as the pipes above this point diminish in size.

Water Mains and Pipes.—The list of the water mains on Broadway shows two and three, of diameters from 12 ins. to 36 ins.; the largest pipes are met between Seventeenth and Twenty-third Sts. Each gas company has as a rule two pipes, one on either side of the street. The Mutual Gas Co.'s pipes extend from Rector to Forty-second St., and are 4 to 16 ins. in diameter. The Equitable Co.'s pipes extend from Great Jones St. to Fifty-eighth St., and are from 6 to 20 ins. in diameter. The Standard Co.'s pipes extend from Twenty-third St. to Forty-second St., on both sides, and are 8 and 10 ins. in diameter. The pipe record of the Consolidated Co. is not given. The New York Steam Heating Co. has a 15-in. main from Rector St. to Wall St., and an 8-in. main from Mail St. to Chambers St.

Sewers.—This is fortunately a simple question. Broadway is on top of a ridge, and drainage is to the right and left, the longest sewer in the street being one of 5 blocks, Spring St. to Canal St. The great Canal St. sewer would have to be rebuilt for a short distance from Broadway eastward, and a district north of Canal St. and adjacent to Broadway on the east which now drains into Canal St. and thence to the North River would drain to the east ward into the East River. There would, therefore, be no necessity for either a pumping station or a siphon at the Canal St. crossing. All that would be required on Broadway therefore, would be small pipes carrying the sewage of the abutting houses, which would turn to the right and to the left, down nearly every cross street.

Equipment.—The design of the tunnel to permit the running of ordinary passenger coaches is neither necessary nor desirable. It would interfere with the regular movement of the trains, for these must be hauled at a speed of 40 miles an hour on the express tracks up 1% grades. To do this the cars must be as light as possible, and the great weight of a train of ordinary coaches would prevent its being run at the regulation speed. An ordinary passenger coach would require a tunnel 14 ft. 10 ins. high. Upon investigation I find it possible to construct a car either of steel or wood that can be run through a tunnel but 10 ft. high. As one track would have to be above the other, the total saving in height is therefore 9 ft. 8 ins. This not only saves excavation and decreases possible interference with foundations, but brings the level of the car floors 6 ft. 8 ins. nearer the surface on express lines and 1 ft. 9 ins. on the other lines. The saving in width by the use of the smaller coaches is 1 ft. 2 ins. per track. The only argument for running ordinary coaches would be the convenience of passengers over the New York Central or New Haven R. R., but these are so small a percentage of the whole that the extra expense of the larger tunnel would not be justifiable.

A letter from D. L. BARNES, Consulting Engineer, approves of cars to run with 10 ft. headway, and states that no unusual or untried systems of suspension or running gear will be necessary in designing such a car. The width and height of the car would, in fact, be the same as on the Elevated R. R. The platforms would be omitted, and the entrance doors would be in the sides near the ends, so that one gateman could attend to two cars, as on the Elevated.

Grades.—It is possible to construct the railway with a ruling grade of 1%, which is just one-half the maximum grade on the present Elevated system. The stations should be located as far as possible at the summits of grades, to facilitate starting and stopping of trains.

Location of Pipes.—In respect to the railway the pipes can be placed overhead, beneath, at the sides, or in the center. The first is very objectionable because the railway level would be depressed about 10 ft.; if the pipes are beneath the railway, the excavation is deep, the pipes are very difficult of access, and moreover, a horizontal pipe chamber is the most inconvenient form, on account of the necessity of carrying pipes over other pipes, in order to repair or replace the central lines. There is not room in Broadway to place the pipes in vertical galleries at the sides of the railway, as pipes in that position would be inconvenient to dispose of at the station. The system of placing the pipes between the tracks, which I have adopted, is the least difficult and most convenient.

Details of the Structure.—The space between the upper tracks, and immediately beneath the cable railway, will be devoted to the pipes and wires. Using a car designed as above, we have a distance from the surface of the street to the floor line of the upper cars of 11 ft.; to the floor line of the lower car 22 ft. 4 ins. Using 7-in. risers on the stairs, but 19 steps would be required to reach the cars on the way tracks, and 38 steps to reach the cars on the express lines. Station platforms would be immediately beneath the sidewalks and about 20 ft. in width. The express train platform would be immediately beneath that of the way trains.

The tunnels would be 12 ft. wide in the clear, the cars would be 8 ft. 8 ins. wide over all, and would be set so as to leave a clear space of 6 or 8 ins. between the sides and the inner wall, thus leaving 2 ft. 8 ins. for a foot walk between the car and the wall next to the buildings. This would be used by the trackmen and the inspectors, and also by passengers in case of an accident. Immediately beneath this walk would be the sewer; and as the walk could be raised or lowered at will, the proper grade of the sewer could be maintained without interfering with the cars at the side. The sewer being beneath the walk, it could be inspected, repaired and maintained without difficulty. It would also be next to the vault walls, so that connections with it could be easily made.

Most of the wires could be passed through the space left by the corrugated iron roof, and be above the tops of the cross girders, entirely out of the way, and yet perfectly accessible for repairs or connections, much more so than the present subway system. Should it be necessary to lay pipes for other purposes than they now serve in the future, the bottom of the pipe gallery can be further excavated and a great increase in size made without interfering with either the railway or pipe gallery. House connections from the pipes in the gallery would be made by passing pipes over the tops of the local cars, and between the 16-in. cross girders. Pipes across the line of Broadway are usually 6 or 8 ins., rarely as large as 16 ins. Pipes larger than 12 ins. can be subdivided where they cross Broadway, and reunited on the other side. Access to the pipe gallery would be from a manhole from the side street, giving access to a chamber beneath the street. At this point the level of the express tracks would be lowered to permit a passageway, 4 ft. in height, being made between the top of a car and the bottom of the stringers supporting the way tracks. Through this cross passageway the length of pipe would be rolled into the pipe chamber, where it would be put upon a small truck and rolled north or south to the point where required. The places convenient for such cross passages would frequently occur at points where the street surface would rise rather abruptly, which the way-track grade would follow, while the express track would keep an unbroken grade. Thus the difference in elevation would give the height necessary for these cross entrances. In the same way, sewers and cross mains could be carried between the two tracks.

The street surface or roof of the tunnel would be composed of iron buckle plates, carrying a body of asphalt, concrete and sand on which would rest the pavement stones. The shallow stamped plate would be used over the railway to economize height, while a deeper riveted form would be put in between cable lines. Possibly before reaching Canal St. the local tracks could be spread, the pipe gallery contracted as much as possible, and the express tracks brought up between them, so that all would be on a level. This would diminish the amount of excavation below water mark at this point.

On the Boulevard I suggest constructing the railway in double tier, adjacent to the curb lines of the parkway and locating the station building in the parkway itself, with the platforms immediately beneath it. The advantage of this form of construction is that the pipes and sewers being on the sides of the streets would not be interfered with. But one station would be required for both up and down lines, and there would be no outlay for real estate for station buildings.

The advantages of a double-deck structure over tracks all on one level are:

1. Local tracks close to the street surface.

2. Fewer stops are required to reach the express tracks than if the passengers had to go over or under the local track to reach the express platform.

3. No divergence in line required to introduce central platform at express stations.

4. Express stations can be added at any time in the future without inconvenience.

5. Avoidance of grade crossings at branch line junctions by lowering the express track on one side and passing the other two tracks between it and the local track above it.

6. In case of accident on local track, service for all stations can be maintained on express lines; or in hours of light traffic, either track could be used for local traffic, leaving the other clear for repairs.

7. The express tracks could be used for the delivery of freight during certain night hours, if suitable stations were constructed.

Ventilation.—The two tracks on each side will be in a practically tight tunnel, as a partition wall of some sort would be put in between the pipe gallery and upper track. There would be an air duct leading from both tunnels, connected with a shaft and supplied with an exhaust fan. At some distance beyond would be a smaller duct and shaft as an inlet for fresh air. The trains in each tunnel, always running in the same direction would, of course, materially assist in setting up the ventilation current. (See paper by N. W. EAYRES, Trans. Am Soc. C. E., Dec. 1890, and also London *Engineering*, Vol. XXXVII., p. 413.)

Mr. J. BELL, General Manager of the Metropolitan Ry. of London, has given me strong testimony to the beneficial facts of this piston action, and stated, that the only reason why they did not put up partition walls in their double-track tunnel was that the train would drive forward all the foul air into the station, where on account of the enlarged section, the current would cease, and it would be impossible to remove the smoke from the station. Sufficient ventilation of the pipe gallery could be had through perforated manholes, or else by special air ducts connected with the main ventilating shafts of the tunnel.

Specifications.—I assume the following loads in preparing the preliminary designs: for the portion beneath the sidewalk, over the track space, 1,500 lbs. per sq. ft.; for the portion over the pipe gallery, 1,000 lbs. per sq. ft., the weight of the structure being included in both cases. This is, of course, excessive for ordinary loads, and is believed to give ample margin for the structure to withstand the shock of the fall of the wall of a building. The unit strains proposed are: Wrought iron, 10,000 lbs. per sq. in.; steel, 12,000 lbs. per sq. in. The weight on the track is assumed at 4,000 lbs. per lineal ft., and the steel cross and track stringers and rolled I beams have unit strains of 10,000 lbs. per sq. in. The columns if of iron, may have unit strains of 8,000 lbs. per sq. in. for 90 radii or under and 10,000 lbs. if of steel. Z columns have been used in the plans presented If cast iron short columns are used, the unit strains will be 7,000 lbs.

Method of Construction.—This railway could be built in several ways without seriously disturbing the street traffic or stopping the cable railway. I suggest the following method:

Take one side of the street at a time and build, in a narrow trench, the side wall; then widen the trench for a distance of 12 ft., put in the foundation concrete and the iron structure for the tracks, and then slips cross, beneath each cast iron yoke of the cable road, cross beams that would support them, in the meantime holding the sand filling in the centre of the street by planks supported by struts against the side wall. Buckle plates could be put immediately in place and paving put down, and thus one-quarter of the street finished completely without interfering with the other three-quarters. Then do the same with the other side of the street. After both sides were completed, attack the center from the sides, and the cross-beams being in place beneath the cable yokes, it would be an easy matter to support them and the center of the street by underpinning the beams as they were successively reached. This could be done two blocks at a time, working toward the intermediate street, the excavated material being carried toward it by buckets on a wire rope carrier and dumped into the carts which would be driven across Broadway and stopped at the end of the trench for a moment or two, while the load was being dumped into them. If each bucket contained a cart load, the cart would be detained but a very short time. This method of construction would not interfere with Broadway street traffic one-half as much as the present cable construction. This would give the advantage of the work being carried on in an open cut. Of course the pipes and wire subways would be supported by hanging them from timbers laid across the trench, and they would remain that way in service until the pipe gallery was constructed and new pipes were in place.

REPORT OF OCTAVE CHANUTE—*Consulting Engineer.*

In my judgment the engineering problem submitted is so complex that the exclusive adoption of any one general plan does not seem the best solution. It seems to be advisable either that working plans shall be made in great detail, or that the specifications of your board shall permit of modifications in making the final plans. The designs of your engineers necessarily omit very many details and modifications. They will need to be both combined and departed from to meet local requirements and promote efficiency.

It seems clear that the underground lines will be subject to the following operating necessities: (a) They will need to be divided into operating sections in order to apportion the train service to the density of the traffic. (b) They will need connecting tracks and switches to shift trains from one track to the other, and also to run around breakdowns should any occur. (c) Long sidings will be required at several points to hold spare cars and motors when not in use. (d) There must be shops for repairs of rolling stock, and storage yards for materials for track repairs, etc. (e) Room is needed in the tunnel for employees to make necessary repairs without material danger to the trains or themselves.

The discussion of the present design for construction will be simplified by dividing the lines into five sections, as follows:

1. Battery to Union Square: sand formation; very dense traffic, very many complications.

2. Union Square to south end Central Park: chiefly rock near surface, dense traffic.

3. Central Park to Manhattanville on west line or Harlem on east line: chiefly rock, considerable traffic.

4. Manhattanville to 181st St. on west line and Harlem to Morrisania on east line: chiefly rock, traffic comparatively light.

5. From above-named termini to city limits: the open country.

Battery to Union Square.—This section, though covering but one-tenth of the proposed railway lines, is by far the most important and the most complicated. The engineering difficulties and the consequent risk of disaster, the narrow limits and the dense traffic, the complications of underground pipes, and the multiple and diverse interests to be protected, inspire the hope that some one design can be invented which will solve all questions and reconcile all interests. I very much doubt myself whether there is such a design in existence, save the old and well tried plan of varying the design and the mode of construction at different points, in accordance with the varying local requirements of the case, under general and rigid restrictions, which shall insure safety and guard existing interests.

The construction over this section will be almost wholly through sand, some of it, perhaps, approaching quicksand in character. As South St. is but 14 ft., Beaver St., 15 ft. and Canal St. 10 ft. above tide, the construction at these points will necessarily go below tide level; and the difficulties of making it water tight increase rapidly with every foot of additional hydraulic head. We are therefore led to consider the advisability of having four tracks on a level at these points. But this leads us into trouble at other points.

Broadway is popularly supposed to be 44 ft. wide between curbs, but there are no less than 37 street crossings between the Battery and Union Square and 12 crossings above Union Square, where it is less than 44 ft., the narrowest being at Rector St., where the width is 34 ft. 4 ins. between curbs. Now the four tracks on a level require a width in the clear of 44 ft., and at many points this will cut into the side vaults, which in some cases have encroached upon the street. So far as can be told from scaling a map, every vault would be cut into from the Battery to Cortlandt St., above this they will be missed as far as Reade St., and from Reade St. to Union Square 32 vaults would be cut, besides those required for the stations.

The design proposed for the double-deck tunnel partly avoids the difficulty about the vaults, though even this, as now planned, is likely to crowd some of them. The general design shows a width of 41 ft. between retaining walls, in consequence of the introduction of a central pipe chamber, designed to do away with the constantly recurring necessity for tearing up the street pavements.

This pipe chamber is an excellent proposition; but as now designed it extends but a little below the bottom of the upper tracks; thus, if a water pipe bursts, the lower tracks may be flooded, the more so as no provision is shown by which they can be drained. I suggest, therefore, that this pipe chamber be made narrower, and be carried down to the bottom of the lower tracks, having for its drainage the hollow crown of an inverted arch, turned between the side walls to keep them asunder.

Such a design will occupy a depth of 25 ft. or 26 ft. below the curb, so that at Canal and Beaver Sts it would extend 16 ft. to 22 ft. below tide level. This suggests that at the Battery, at least, it would be preferable to adopt the design having all the tracks at the same level. At Canal St. I believe this arrangement will not save much depth, because it will occupy some 22 ft. of height.

The design for placing all four tracks on a level seeks to avoid all complications about pipes by driving a "roof shield" under them at a depth of 7 ft. 9 ins. below the curb; but the diagrams prepared by the engineers of the Broadway Cable Railway exhibit some of the pipes at a depth of 11 and 12 ft. below the surface. Probably the lowest of them could be raised; but it seems likely that the top of the four track "roofing shield" would have to go at least 9½ ft. below the surface, and that the total depth would be some 22 ft. below the curb, instead of 20 ft. as shown, with no provision for drainage at the bottom.

It seems to me the weak point about this plan is its proposed method of execution. It provides for the driving forward of a "roof shield" or hood, consisting of isolated iron beams with cover plates attached, sliding past each other and supported by temporary posts resting upon the sand below. In clay or firm soil this method, which is known as the needle-beam or horizontal sheet-pile system, has given good results; but I believe it to be inappropriate to sand of the degree of fineness revealed by some of the borings, especially when mixed with boulders. Much of it, it is true, is dry, coarse, sharp and gritty, and will retain a fair slope, but some of it is impalpable, produced by the grinding down of the gneiss rock, and will, when wet, assume a very flat slope. There would be, in my judgment, very great danger of disaster, if the attempts were made to drive a "roof shield" through this sand, under the existing sewers, steam, gas and water pipes, subways and cable road tracks. If a wet section were struck, and there are sure to be some wet spots from leaky pipes, to say nothing of those pipes which may be broken while driving the needle beams forward, the fine sand would run away like water from under the temporary posts which sustained the overhead shield, and the whole street might cave in, as well as some of the adjoining buildings.

Moreover, no provision is shown for supporting the side thrust or pressure, due to the weight of the material and that of the adjoining foundations. The vault walls can not be relied upon to resist this thrust, because they do not extend deep enough. There are on Broadway below Union Square not less than 270 foundations which reach less than 15 ft. in depth, and the excavations must go at least 10 ft. below this, say an aggregate of 25 ft., while some of the house foundations are only 4 ft. deep, and those of Trinity Church are only 9 ft. 4 ins. on the Broadway side.

I cannot advise the attempt to tunnel through this sand with nothing but a "roofing shield;" the risks would be too great, and the difficulties too formidable to warrant the undertaking. The street must, as I think, be attacked either with shields enclosed all around, or else from the top, as is proposed for the double decked design, in order that the excavations and trenches may be thoroughly braced or strutted across, and all movements prevented. I fully concede that it is most desirable that the work should be carried on, if possible, without disturbing the surface of the street anywhere, and without interference with its traffic; but I doubt whether it can be accomplished throughout within limits of cost which will not prove prohibitory. It may be done through certain parts, and under several stretches, and I am informed that several meritorious designs have been submitted to your Board, which propose to accomplish this; but I believe that on a very considerable part of the lines a certain amount of interference with the street traffic by tearing up the pavements will be part of the price which the public will have to pay to secure underground rapid transit. We can judge approximately what this will amount to by the present experience in the building of the cable railway. I think that the annoyance need be no greater, because as soon as the trenching has been fairly started it can be covered over and the street traffic carried through upon rolling bridges, somewhat as proposed by the Arcade Ry., or upon a series of rolling platforms, as proposed for use in the City of Paris (France), and illustrated in ENGINEERING NEWS of Dec. 13, 1890. Such present interference with traffic will be much more than repaid in future years, if a pipe chamber be provided for, by the permanent relief from the necessity for tearing up the pavement in order to lay down new pipes, or to repair old ones.

Along certain blocks, where a detailed study of the surrounding conditions shall indicate that it is not best to proceed from the surface down, it may be advisable to tunnel through by some of the systems of enclosed shields, filled up by a water excluding construction; but such systems are not only costly through wet sand and boulders, when properly proportioned to resist all thrusts and to avoid all possible disasters, but they are also ill adapted to provide for connecting tracks and sidings, so that it seems probable that on much of the lines the same methods will need to be resorted to by which the foundations of the existing buildings have been put in, and carried down in some cases as deep as 30 ft.

The following are the designs which, with my present knowledge, seem to be most appropriate to section 1:

From the battery to Beaver St., I believe the design of Mr. WORTHEN for a single track loop line without pipe chamber, is the preferable one to adopt. Its depth is but 13 ft. 6 ins., its length but 1,300 to 1,500 ft., and it can accommodate all the local trains and such express trains as may run to South Ferry. Somewhere above Beaver St. the two additional tracks may branch out; but I also approve of Mr. WORTHEN'S design for a loop around City Hall Park to connect with the Brooklyn Bridge and reverse trains without switching. I am not clear whether

it is best to use any double deck structure below City Hall Park or to keep all four tracks on a level. The former plan would probably interfere with arranging the loop tracks to avoid grade crossings, a thing most desirable to accomplish.

From City Hall Park to Clinton Place I would recommend a double-deck structure with a pipe chamber 6 or 7 feet narrower than the one designed by Mr. Parsons, and extending down to the lower tracks. It would be possible within limits of a 1% grade to have a double-deck structure at Park Place and bring all four tracks on a level at Lispenard street in order to save depth at Canal street. But if the latter location proves wet, I had rather drive through it by means of closed shields and water tight construction than change the design of the structure. There are probably several other points where the use of closed shields would be advisable.

The Reno tunnel system presented to your board, which has no pipe chamber, occupies 13 ft. less between side walls than the recommended double deck structure, but it goes down 13 ft. deeper. I think the additional cost and risk involved by this additional depth of 13 ft. is very great.

The double deck design may be arranged in a variety of ways, for instance with three tracks on a level and the fourth track centrally under them, thus providing a pipe chamber under each outer track. This is mentioned chiefly to indicate that to confine the specifications to "two tracks upon each deck" might not be wise, as this may cramp the design.

The pipe chamber will need to be separately enclosed and ventilated to exclude leaking gas from the passenger tunnels, and the latter should be separated by strong partitions, both to confine each train to its own tunnel, and to improve the ventilation. Drainage will need to be provided for by sub-drains to sumps at suitable points.

From Clinton Place to Union Square, 1,600 ft., I would bring the tracks gradually to the same level, both to diminish rock excavation and provide for the junction at Union Square.

A series of side tracks under Union Square would much add to the convenience in operating; and a loop line under the walks in Madison Square would permit many trains to be returned around bodily, and thus better apportion the train service to the traffic.

My impression is, that it will be sufficient to carry the pipe chamber from Rector St. to Union Square.

Union Square to Central Park.—In the vicinity of Union Square rock comes near the surface, and continues all the way to the upper part of the Island on both projected lines. It is rugged and broken, full of pot holes and fissures; and further surveys are required before it can be determined how it is best to attack it.

The previous argument against an overhead shield referred to its use in the sand in lower Broadway; but there are other considerations which would tell against the shield here. There would doubtless be points where its roof would be near the division line between the earth filling and the rock; and the necessary blasting under the pipes and sewers would be exceedingly dangerous. On the other hand, if the excavations proceed from the top downward, progress would be intolerably tedious, and the street would be torn up a long time. It is my opinion that the preferable plan above Thirty-second St. would be to sink a series of shafts to the bottom of the desired excavation, and thence to work up to the determined height. From the meagre information available, I believe a double deck design will be preferable from Union Square to Thirty-fifth St., and above this point, where Broadway becomes 60 ft. wide between curbs, to adopt the design of four tracks on the same level. A loop line and side tracks should be provided under a corner of Central Park.

Upon the East side line the construction should be a tunnel in the rock, with four tracks on a level under the existing street car tunnel on Fourth Ave. to Forty-second St., and under Madison Ave. as far as Central Park.

Central Park to Manhattanville and Harlem.—Along the Boulevard I would place the four tracks on the same level just under the pavement, both to make them more accessible to the public, and to avoid striking those deep seated springs which sometimes prove so troublesome. The rock is here very close to the surface, and accurate surveys will determine whether to sink shafts to the bottom of the excavation, and drift horizontally from the heading, enlarging eventually to the top, or to proceed from the top downward through the earth covering, and thence into the rock.

On the East side line the surveys will probably show that it is best to drive a tunnel for four tracks on a level as far as Ninety-sixth St., where the viaduct is to begin.

Manhattanville to 181st St. and Harlem to Morrisania.—I believe that the work upon this section can be carried on from the surface downward without materially interfering with the street traffic. Possibly it would be judicious to build only two tracks at first on this section, over which trains could run as locals as far as Manhattanville, and as express trains below that point, until business warranted building the other two tracks.

181st St. and Morrisania to City Limits.—Here business is at present so thin that probably it is best to build an ordinary surface line which shall be cheap enough to pay. Business might first be developed by a surface electric road with steep grades and crooked lines to fit the ground. Such roads are now operated elsewhere, some of them with curves of 50 ft. radius, and gradients of 10 and even 14%, at speeds of 7 to 10 miles per hour.

Equipment.—I agree with Mr. Parsons that ordinary passenger coaches need not be provided for, and that cars may be constructed standing somewhat lower than the cars in standard use. However, they might be rather cramped if designed to run in a tunnel 10 ft. high, so I have assumed a minimum height of 10 ft. 6 ins. in my estimate of the depth of the tunnels. I agree that the cars should be closely vestibuled, and should be entered and left from the sides, as is the practice in Europe. It might be well also to provide the doors with a joint locking handle under control of the trainmen.

I commend Mr. Parsons' proposal to locate gradients on the approaches to local stations wherever practicable, to assist trains in starting and stopping. The track will have to be on metal supports, with some cushioning arrangements, and with massive proportions.

There will be need of rigid specifications as to the precautions to be observed in carrying on the work. A certain latitude may be allowed in the designs, but there should be none in the requirements for strength and safety.

Report of John Bogart, *Consulting Engineer.*

Mr. Bogart discusses at considerable length, the question whether the construction of subways or tunnels for sewer, gas and water pipes, electrical conductors, etc., is an essential feature of plans for a rapid transit railway. Quoting the law, he concludes that unless such a system of subways is essential to the proper construction of the railway, the Commission need not provide it. He says that a proper system of subways would be a great boon to the citizens, and it would perhaps not be quite proper that a plan for a rapid transit railway should be adopted which would interfere with the construction of suitable subways in the future. The plan submitted by Mr. Worthen is the more economical in the disposition made of the pipes, and admits of their future disposal in subways when desired.

The provision for express trains and way service upon separate tracks, so located as to facilitate at proper intervals an exchange from one to the other, is complied with by both systems, but would be more easily accomplished with the tracks upon the same level. Another requirement is that the surface of streets should be obstructed as little as possible. In building Mr. Parsons' double-deck railway, a trench 12 ft. wide must be excavated, first on one side of the street and afterward on the other. This, of course, could be covered temporarily after a moderate depth is reached. Mr. Worthen proposes a tunnel, and the question arises whether the material under Broadway could be securely retained and prevented from falling into the excavation during the progress of the work. This question is, in my opinion, the most serious one connected with the construction of such a depressed road. I am assured, however, by persons of large experience in tunnel and sewer construction, that a tunnel can be successfully carried through the sand underlying Broadway below Union Square without endangering the stability of the pipes and pavements, the top of the tunnel being at the moderate depth of 7 ft. 9 in. below the curb.

I do not consider that there is danger to the foundations of houses and structures from the construction of either of the proposed plans, when carried out under proper supervision. Of course the less the depth of the depressed road and its foundations, the less would be the danger.

In Mr. Worthen's plan, the outer tracks are curved so as to run under the sidewalk at all express stations, and the approach to the platform is over this outer track. But as only the way tracks are thus curved, such curving is not in my opinion disadvantageous.

I suggest that a large portion of the stations be made to give access to both way and express tracks, to permit the use of one track for the purpose originally assigned to the other when necessary.

In my opinion it is not necessary to so construct the tunnel as to permit of the passage of freight and passenger cars in use on standard steam railroads.

It seems to me very important that the four tracks should be so laid as to permit the transfer from any track to either of the other tracks at many points along the line. In this respect the 4-track-level plan is the superior.

I think that a footway at least 2 ft. wide should be provided the whole length of the line.

In my judgment tracks for a railway with such an enormous traffic had better be founded upon the natural ground, if possible, than upon a structure subject to constant vibration.

Mr. Worthen's plan for two tracks below the City Hall could be modified to provide 4 or 3 tracks, the latter, in my opinion, being preferable to only two.

Summarizing, I consider that a plan can be adopted whose proper construction does not necessarily require a provision for pipe or wire subways. In the event of a future construction of subways, pipes, etc., they would be well placed over the roof of the depressed railway. I doubt the expediency of placing some of the pipes, particularly the gas pipes, under a covered railway. I have become satisfied that motors, probably with the use of electricity or compressed air, will be so perfected in construction as to give rapid speed without vitiating the air. I think the ventilation of the tunnel can be made perfect without difficulty by the constant introduction of fresh air.

In my judgment the method and plan in general, as suggested by Mr. Worthen, is the best practical mode of construction of a depressed rapid transit railway, having due regard to reasonable economy of expenditure, probable return on capital invested, and the full measure of capacity of passenger service.

Railways and Tramways in New South Wales.

In August last the Railway Commissioners of New South Wales, Australia, presented to the legislature their report for the year ending June 30. No new lines were built, but about 108 miles of track were relaid with 80-lb. rails to replace the old 70-lb. rails, and where chairs were used the new ones weigh 40 lbs. as compared with 25 lbs. for the old ones. Progress is being made in the interlocking of switches and signals, and the absolute block system of operation. The block telegraph system of working on single and double track is also being extended. Nearly the whole of the southern mail line to Albury, 386 miles, is worked in this way, and 80.51% of the stations and sidetracks on that line have interlocking plant. Tyler's tablet, and Webb & Thompson's electric train staff instruments have been ordered for the operation of all the lines having much traffic. All through and important trains are now fitted with electric communication between the passengers and conductors. In regard to the brake question and test of brakes, it is said that the performance of the vacuum brake was excellent, but for reasons assigned in the report, and looking at the merits of the Westinghouse brake in itself, it was decided to adopt the latter. In view of the great advantages of having a continuous brake on the freight cars it is urged that the work of fitting the brake to the cars be proceeded with as rapidly as possible. The passenger equipment is said to be in good condition, but the freight equipment requires considerable improvement. Some work is to be done in reducing the curves and grades, and the present policy of the Commissioners is to employ more powerful engines and to reduce

RAILWAYS.

	1891.	1890.	1888.
Total spent on construction and equipment	$ 158,843,085	152,775,615	138,613,740
Total debentures finally paid off	$ 5,695,875	5,545,375	5,089,375
Total cost less debentures paid off	$ 153,147,210	147,230,240	133,524,365
Total cost per mile open	$ 72,795	70,015	65,570
Total mileage open	2,182	2,182	2,144
Average miles opened for the year	2,182	2,182	2,044
Gross revenue	$ 14,872,105	13,165,430	11,475,620
Working expenses	$ 9,156,855	8,329,175	7,652,755
Profit on working	$ 5,715,250	4,836,255	3,822,855
Percentage of working expenses to revenue	61.57%	63.26%	66.69%
Earnings per average mile open	$ 6,815	6,045	5,610
Expenditure per average mile open	$ 4,195	3,825	3,740
Gross earnings per train mile	cts. 169.76	157.80	161.68
Exps. per train mile	cts. 104.52	99.82	100.82
Net profit per mile	cts 65.24	57.98	54.86
Number of passenger journeys	19,037,760	17,071,945	15,174,115
Freight tonnage	3,686,998	3,630,718	3,331,671
Live stock tonnage	115,851	108,232	98,101
Train mileage	8,410,421	8,008,826	6,669,313
Locomotives	470	459	428
Passenger cars	1,023	1,064	1,039
Freight cars	9,940	9,304	8,833

TRAMWAYS.

	1891.	1890.	1888.
Total debentures issued and outstanding	$ 5,000,000	5,000,000	5,000 000
Amount added to capital account	$ 352,900	120,095	339,645
Total spent in construction and equipment	$ 5,621,000	4,608,070	4,386,220
Total cost per mile open for traffic	$ 118,140	118,180	113,930
Total mileage open	42¾	39¼	38½
Gross revenue	$ 1,464,250	1,344,810	1,182,595
Working expenditure	$ 1,198,305	1,120,365	1,008,980
Profit on working	$ 265,855	224,445	80,615

the percentage of dead load of the freight cars. It is sensibly recommended that for railway extensions where the country is practically level and the traffic will be very light, "pioneer" or light railways should be built at a cost of about $8,700 per mile, exclusive of bridges and land, and trains run by daylight only and at a speed of about 15 miles per hour. When the traffic has developed the lines can be improved.

In regard to the tramways or street railways, it is stated that about 2 miles were built during the year. The rolling stock is in good condition, but all of the double-deck cars have been withdrawn, and those capable of further service are retained for long and holiday traffic. The lines include the City & Suburban lines, 33½ miles; North Shore Cable line, 1½ miles; Newcastle & Plattsburg, 7½ miles; total, 42½ miles. A great proportion of the city and suburban lines require to be relaid, and where the roads have wood block paving the cost will be considerable.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Altoona & Wapsononock.—The contract for building the extension to Frugality, Pa., has been let to McAteer & Son, and work is now in progress. It is expected to have the line completed to the Dougherty coal mines by Nov. 1.

Adirondack & St. Lawrence.—The Enterprise Construction Co. has been let the contract for building 2,000 cu. yds. of masonry for bridge abutments at Moose River to Frank A. Barrett, Boonville, N. Y., and the contract for clearing 5 miles of forest to J. L. & J. McBeth.

Brookline & Pepperell.—The contract for building this railway is reported let. The road is to run from Groton, Mass. to Brookline, N. H., 13 miles. Augustus W. Locke, North Adams, Mass., Chief Engineer.

Boston & Maine.—Surveys are in progress for a branch from Groton, Mass., to Faye Village, Mass.

Lower Laurentian.—It is expected to have this entire road between Three Rivers and Riviere à Pere, P. Q., completed this month.

Dutchess County.—Nearly all of the right of way between Poughkeepsie and Hopewell Junction, N. Y., 12 miles, has been secured, and grading is making good progress. The rails will begin to arrive this week.

Lehigh Valley.—Chief Engineer Paul S. King is reported as saying that the first track between Buffalo and Geneva, N. Y., will be completed about Nov. 5, and that the laying of the second track will be begun at once. It is expected to have the entire road open for business by Aug. 1, 1892.

Toronto Belt Line.—H. Curry, Toronto, Ont., Chief Engineer, writes us that the grading on this railway is practically completed, and that 8½ miles of track have been laid. The road consists of 2 loops. One runs from the water front in the eastern part of the city through North Toronto and Fairbank to the Northern Ry., a distance of 8½ miles. The other will run from Carlton west and south to Swanora, a distance of 4⅝ miles. The work is fairly light. One-third of the total mileage has a grade varying from 1.5% to 3.35%. There is one curve of 10°, and several of 8°. The route is through the suburbs of the city of Toronto and the business of the road will be the suburban passenger and freight traffic. It is expected to have the entire line open for traffic by Nov. 15.

Projects and Surveys.

Geneva & Southwestern.—A project is on foot to build a railway from Stanley to Naples, N. Y., along the east shore of Canandaigua Lake. It is proposed to use a large part of the old roadbed of this road. New York capitalists are said to be interested in the scheme.

Southbridge, Sturbridge & Brookfield.—The preliminary preparations for the construction of this Massachusetts road are said to be making good progress and it seems probable that the line will be built.

Washington & Chesapeake Beach.—T. W. Tyrer, of Washington, D. C., Secretary, writes as follows:

Arrangements are all perfected to begin work on this railway as soon as the officers are elected, which will be Nov. 15. The road is projected to run from Washington, D. C., via Marlborough, to Chesapeake Bay, a distance of 30 miles. The surveys have been completed and the right of way secured. There will be one bridge with a 24 ft. draw. The principal business of the road will be the suburban and seaside passenger traffic. Contracts will be let on Nov. 18, and it is expected to have the line completed about April 1, 1892. The company was chartered Sept. 1, 1891. L. H. Hyer is Chief Engineer.

SOUTHERN.—Existing Roads.

Ohio Valley.—The contract for the first 5 miles of the extension from Princeton to Hopkinsville, Ky., have been let to Morgan & Co., of Clarksville, Ky. Work is reported in progress.

Branchville & Bowman.—A press dispatch states that tracklaying will soon begin on this 12-mile railway from Branchville to Bowman, S. C.

Florida, Georgia & Western.—A large quantity of rails and track material has been shipped to this railway at Tallahassee, and tracklaying will soon begin.

Norfolk & Western.—The contractors, Rogers & O'Brien, expect to complete the 1¼-mile belt line at Roanoke, Va., by Nov. 1.

Middle Georgia & Atlantic.—Arthur Pew, of Savannah, Ga., Chief Engineer, writes us that 18 miles of this railway are in operation and that 20 miles of track have been laid and 25 miles graded. No further contracts have been let yet. Two preliminary lines have been surveyed between Savannah and Statesboro, Ga., 50 miles. The road is projected to run from Hutchinson Island, in the Savannah River, at a point opposite the city of Savannah, via. Statesboro, Tennille, Eatontown and Machen, to Covington, Ga., 225 miles. There will be a bridge across the Savannah River consisting of a 210-ft. draw span and two 100-ft. fixed spans; and also iron bridges over the Ogechee and Oconee rivers.

Bishopville.—A correspondent writes us that this road has been extended 8 miles from Bishopville north to Lucknow, S. C. It is yet undecided whether its destination will be Kershaw or Lancaster, S. C., or Monroe or Charlotte, N. C.

Projects and Surveys.

Georgia.—Charters for the following railway companies have been filed with the Secretary of State of Georgia: Brunswick, La Grange & Northwestern R. R. Co.; from Brunswick to Alabama line; capital stock, $200,000; incorporators, W. J. Weeks, E. B. Lewis, W. B. Burroughs.—McRhea, Acilla & Southwestern Ry. Co.; McRhea to Thomasville; capital stock, $100,000; incorporators, C. A. Buckley, J. S. Syndam, H. J. Smith.—Thompson & Lincolnton R. R. Co.; Thompson to Lincolnton; incorporators, T. E. Watson, J. E. Smith, J. E. Strather.—Smithville & Hawkinsville R. R. Co.; Smithville to Hawkinsville; capital stock, $40,000; incorporators W. C. Gill, E. Taylor, John S. Bryan.

Hemlock.—Chartered in West Virginia to build a railway from the sawmills of Work, Wilson & Co., on Jenks Fork of Middlefork River in Upshur Co., to the mouth of Panther Fork Creek, in the same county. Among the incorporators are W. V. Caldwell and W. W. Martin, of Washington Co., Pa.

St. John's Shore & Panama Park Belt Line.—This company, recently chartered in Florida, proposes to build a railroad from Jacksonville to Panama Park, and thence along the St. John's River to the point of beginning, a distance of 10 miles. Among the incorporators are T. V. Cashens, G. W. Gill, J. F. Nichols and Henry Maynard.

Hawesville & Hancock County.—It is stated that Pittsburg, Pa., capitalists have a scheme on foot to build a spur railway from Hawesville, Ky., to mineral lands in Hancock Co., a distance of 6 or 7 miles.

NORTHWEST.—Existing Roads.

St. Paul & Duluth.—It is reported that this company will abandon its present short line between West Duluth and Thompson, Minn., and will rebuild the old line.

Duluth, Pierre & Black Hills.—It is reported that all arrangements have been completed for commencing work on the section from Aberdeen to Oakes, N. Dak., and that a considerable amount of tracklaying will be done this year. The grading on the division between Pierre and Aberdeen is well advanced, 60 miles being completed from Aberdeen south and 15 miles from Pierre north.

Southern Iowa.—Paul Morton, of 910 Rookery Building, Chicago, President, writes us that this company proposes to build branches from existing railways to coal mines in Wappello Co., Ia. About 4 miles are already constructed. The line will be from 25 to 30 miles long when completed.

Projects and Surveys.

Drummond & Southwestern.—Chartered in Wisconsin to build a railway from Drummond, Wis., to a point in Bayfield Co., a distance of 7 miles. Among the incorporators are R. E. Rust, John H. Owen and John H. Rust, of Eau Claire, Wis.

Chicago Union Transfer Co.—It is stated that this company has decided to build a belt line railway around the city of Chicago, closely paralleling the present City Belt Ry.

SOUTHWEST.—Existing Roads.

Corpus Christi & South American.—A press dispatch from Corpus Christi, Tex., states that work will be resumed on this railway within one month.

New Orleans & Northwestern.—This company has submitted a proposition for the extension of its line to Bastrop, La., to the citizens of Moorhead Parish.

Cleveland, St. Louis & Kansas City.—A movement is again on foot to reorganize this company and complete its lines as projected. The name of the proposed new company is the Missouri Midland.

Missouri Pacific.—Surveys have been completed for the proposed line from Tilden, Ark., to Harlana, Ark., 13 miles.

Kansas City, Watkins & Gulf.—Work, which was stopped some weeks ago on this road, has been resumed, and will, it is stated, be rapidly pushed.

St. Louis & Hannibal.—The citizens of Hannibal, Mo., and Ralls county, have raised the money necessary to secure the proposed extensions of this railway from Perry to New London, Mo., 18 miles, and from Oakwood to Hannibal, Mo., 3 miles.

ROCKY MT. AND PACIFIC.—Existing Roads.

Atchison, Topeka & Santa Fe.—This company proposes to build a railway from Los Angeles to South Riverside, Cal.

Great Northern.—A press dispatch from Chicago dated Sept. 29, says:

The entire line of the Great Northern's extension to the Flathead Valley and the Pacific is in an advanced stage of construction from the Rockies to a point near Spokane. The rails are down to McCarthysville, 7 miles west of the summit of the main range, and the steel will reach Kalispell early in November. Though in the midst of stupendous mountains, more jagged and abysmal than in any other part of the Rockies, the line is carried over the summit with a maximum gradient of only 52 ft. a mile. The company has finished grading extensive yards for the division at Kalispell, which is in the center of the valley and at the junction of five logging streams.

Rio Grande Western.—About 1,000 men are now at work on the Eureka branch of this road in Utah. The grading is now finished to 3 miles beyond Payson, and tracklaying is only a short distance behind. The forces are now at work in the Jordan Pass, where the work is very difficult. When this is finished they will enter the Goshen Valley, where for 18 miles work will be light. Between the valley and Eureka the work will be heavy again. It is expected to have the line completed to Goshen by Oct. 15, and to Eureka by Jan. 1, 1892.

Cascade Portage.—The short railway around the Cascades of the Columbia River, for which the State Legislature of Oregon voted $60,000 at its last session, is completed, and will be opened for traffic soon. The road is owned entirely by the State.

Projects and Surveys.

Butte & Anaconda.—Marcus Daley, part owner of the Anaconda copper mine, is reported as saying that surveys were yet in progress for the proposed railway from Butte City, Mont., to the mine. The road is projected in the interest of the owners of the mine to afford an independent outlet for its ores.

Utah, Wyoming & Eastern.—This company has been chartered in Wyoming to build lines of railway aggregating in length 935 miles, all in the State of Wyoming. The incorporators are Alfred Thompson, Salt Lake City, Utah; Geo. W. Carleton, Hillard, Wyo., and Oliver D. Marx, of Evanston, Wyo.

Denver, Apex & Western.—This company has announced that it will soon begin the construction of a railway from Denver to Leadwood. The Apex Construction Co. has been chartered to build the line. The locating surveys have been completed, and estimates are being received for construction. The work will be sublet. According to reports the route selected will necessitate the boring of a tunnel through the mountains west of Georgetown to cost $80,000. The road is to be standard gage with maximum grade of 2% and a maximum curve of 12°. Contracts for building the first section of 23 miles will be let at once. Roswell E. Briggs, of Denver, Colo., is interested.

Saltair.—Chartered in Utah to build a railway from Salt Lake City to the shores of the Great Salt Lake, a distance of 15 miles. Among the incorporators are Geo Q. Cannon, Joseph F. Smith and H. W. Clayton, all of Salt Lake City.

Port Angeles Southern.—Locating surveys are in progress between Port Angeles and Port Discovery Bay, Wash.

Montana, Idaho & Pacific.—This road is projected to run from Butte City, Mont., via Boise City, Idaho, to San Francisco, Cal., a distance of about 1,050 miles. The line has been surveyed from Butte City to Boise City, 400 miles. A very favorable route is said to have been secured. The maximum grade will be about 2% and the maximum curve 10°. The projectors think that the road can be built for from $16,000 to $18,000 per mile. O. L. Miller of Boise City, Utah, is interested.

CITY TRANSIT.

Electric Railways.—***Waterville, Me.***—It is proposed to convert the horse railway to an electric system.

Weymouth, Mass.—Work on the electric railway is to be commenced shortly.

Taunton, Mass.—An electric railway through Dighton, Somerset and Pottersville to Fall River is projected.

Hartford, Conn.—The Hartford & Wethersfield Horse Ry. Co. has applied for permission to adopt electric traction, using an overhead wire system.

Lockport, N. Y.—The Lockport & Olcott Beach Electric Street Ry. Co. will build a single track road and use the overhead wire system.

Mahanoy City, Pa.—Contracts have been let for the Mahanoy, Shenandoah, Girardville and Ashland electric road.

Easton, Pa.—The Weygadt Mountain Ry. Co. will build an electric and gravity road 2 miles long. President, J. M. Young.

Baltimore, Md.—The North Avenue Electric Ry. Co. has awarded the construction contract to E. D. Smith & Co., of Baltimore.

Groveland, Md.—An electric road is projected by the West Arlington Improvement Co.

Knoxville, Tenn.—A franchise for the Market Square

& Southside line to Middlebrook Park, 5 miles, has been granted to S. W. Miller, of Findlay, O., and others.

Wilmington, N. C.—A syndicate proposes to purchase the street railway and adopt an electric system.

Atlanta, Ga.—The Atlanta Consolidated Street Ry. Co. has been organized, and proposes to adopt electric traction on all the consolidated roads. President, Joel Hart.

Defiance, O.—The Defiance Light & Power Co. has been granted a franchise for an electric railway.

Toronto, Ont.—The council has leased the street railway for 25 years to a company, with power to adopt other motive power than horses, the council to select the particular motor. Public opinion is said to be divided between the electric and cable systems. The city engineer has been sent to the United States to inquire into systems in use in the large cities here.

Vancouver, B. C.—The city proposes to purchase the electric railway for $300,000.

Elevated Railways.—*Brooklyn, N. Y.*—The Kings County Elevated Ry. Co. has awarded the contract for the iron work of its extension from Van Sicklen Ave. to Montauk Ave., 10 blocks, to the Phœnix Bridge Co.

Chicago, Ill.—The Elevated Tramway Co. has been incorporated by A. T. Kelliher, J. W. Bennett and D. W. Proctor, to build roads on the Kelliher system. Capital stock, $125,000.

Horse Railways.—*New York, N. Y.*—The Fifth Avenue Ry. Co. has been organized. President, Thomas B. Musgrave; Vice-President, E. V. Loew; Secretary, I. B. Newcombe.

Pepperell, Mass.—The Brookline & Pepperell R. R. Co. has been organized by Chas. Fairchild, of Boston; T. S. Hittinger, of Townsend, and Franklin Worcester, of Hollis, N. H., to build a standard gage street railway, 10 miles long, between West Groton and Pepperell. Capital stock, $200,000; $110,000 subscribed and 10% paid in.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Detroit, Mich.*—Bids for building a stone arch bridge over the canal near Belle Isle Park will be received by the Board of Park and Boulevard Commissioners.

Howardsville, Va.—A bridge to cost $23,000 is projected across the James River at this place. Address the Virginia Steel, Iron & Slate Co.

Mason Co., W. Va.—The Mason County Court has asked for plans for several steel highway bridges over streams in this county.

Wales, N. Y.—The town board has authorized the commissioner of highways to build a new iron bridge over Hunter's Creek on the Caterline road.

New Brunswick, N. J.—The Board of Freeholders have decided to build a stone arch bridge over the Raritan River at Albany St. The bridge is to cost not more than $100,000, and the county will issue bonds to provide for its construction.

HIGHWAYS.

South Carolina.—York Co. and the town of Rock Hill together are to macadamize the main roads for 10 miles in all directions as an inducement to the farmers to draw the cotton and produce there to exchange for supplies.

Connecticut.—Groton has voted to issue $10,000 for road improvements.

New York.—The Supervisors of Queens Co., have decided to proceed with the macadamizing of the Jericho turnpike. The improvement will cost at least 200,000 and will be paid for by the towns of Jamaica, Hempstead and North Hempstead. The board will open bids at the court house in Long Island City, on Oct. 20. The work will be let in two sections, but contractors may bid for both.

New Jersey.—The Board of Freeholders of Hudson Co. will have commissioners appointed to assess the values of the property to be acquired for the new county boulevard. This drive will extend from the Kill von Kull north to the Bergen Co. line, thus going the entire length of Hudson Co. The Legislature appropriated $1,000,000 for its construction and it is said the road will be completed by the end of 1892. The roadway will be 60 ft. wide, the sidewalks 10 ft. wide each, and the drive will be 14 miles long.

Wisconsin.—Washburn Co. has decided to build 35 miles of road to open up the country around Schell Lake.

Colorado.—The Woody Creek Toll Road Co. has been incorporated at Colorado Springs, by W. E. Newberry, D. M. Hyman and Dr. Henry Paul; capital stock, $15,000. The road will be built from a point on the Colorado Midland R. R., near the confluence of Woody Creek with the Roaring Fork River, and will extend in a generally southeasterly direction. It will cross the river and then extend along the valley of Woody Creek to a point one mile above the Varney tunnel, a distance of about 8 miles.

WATER-WORKS.

NEW ENGLAND.

Squirrel Island, Me.—It is reported that works will be built next spring.

Bellows Falls, Vt.—Meters will be placed on all but domestic services.

Bennington, Vt.—Lake Hancock and Marshall's Pond have been bought by the company to supplement the water supply.

Bethel, Vt.—The Selectmen have been petitioned to enlarge the fire district with a view to building works.

Cambridge, Mass.—A water board petition for $30,000 to replace 24,000 ft. of 3-in. pipe and set new hydrants has been approved by the aldermen.

Easthampton, Mass.—A new supply of water from Pomeroy Brook is under consideration.

Hanover, Mass.—The Hanover Water Co. has recently organized and has applied to the Abington and Rockland Commissioners for the purchase of water to supply the town.

Haverhill, Mass.—Oct. 12 the city will take formal possession of the Aqueduct Co.'s plant.

New Bedford, Mass.—Pipe has been ordered laid on several streets.

Newton, Mass.—An appropriation of $4,603 has been made for new mains and $1,200 for enlarging the pumping station at Newton Upper Falls.

Pittsfield, Mass.—An engineer will be employed to report on improvements, including a new pumping station.

Springfield, Mass.—Two ponds and mill privileges have been bought at the head of Jabsh Brook. It is said that a dam will be built to form a storage reservoir.

Stockbridge, Mass.—There is talk of a new supply to be introduced by the company or the town, the latter having been given power in 1889 to build works. Surveys are being made from Lake Averic, 4 or 5 miles distant.

Stoughton, Mass.—G. O. Wentworth, E. C. Monk and H. L. Johnson have been appointed by a town meeting to ascertain the selling price of the company's works and whether the latter has forfeited its franchise.

Taunton, Mass.—An appropriation of $28,000 has been made for new mains, and 4% 20-year bonds ordered issued.

New Britain, Conn.—C. H. Beaton, Secretary, has sent the following:

The contract for building the new Shuttle Meadow Dam has been awarded to the Troy (N. Y.) Public Works Co. for $31,032. The highest bidder was G. N. Vaughan, Springfield, Mass., $43,630. There were six bids.

MIDDLE.

Cortland, N. Y.—It is reported that the works have passed from Moffett, Hodgkins & Clarke, Syracuse, to L. J. Fitzgerald and B. F. Taylor, Cortland, and that improvements are promised.

East Syracuse, N. Y.—Village works are talked of.

Herkimer, N. Y.—It is reported that a gravity system will be substituted for the present one. C. W. Knight, Rome, will report on the same.

Jamestown, N. Y.—The Board of Public Works recommends that if suitable arrangements cannot be made with the company to supply water to *all* applicants, to supply water for flushing sewers and to reduce hydrant rental, then that the Board be instructed to secure estimates of the cost of municipal works.

Millbrook, N. Y.—It is reported that the Improvement Society will probably advocate the building of works.

Oneida, N. Y.—The purchase of land for a new storage reservoir is under consideration.

Port Jefferson, N. Y.—A small expenditure for fire protection is talked of.

Walden, N. Y.—It is estimated that works, including pumps, stand-pipe and filter, can be built for $25,000.

Perth Amboy, N. J.—J. C. Rossi has been appointed chief engineer of construction of the new city works.

Yonkers, N. Y.—We are informed that the highest and lowest bids for the new stand-pipe were, respectively Robinson & Smith, $17,808, and Morris, Tasker & Co., Philadelphia, $8,317.

McKeesport, Pa.—Councils have voted to advertise for two 3,000,000-gall. pumps.

Philadelphia, Pa.—The Councils Water Committee has approved the request of Director Windrim for $75,000 from the recent loan for a new pump at the Roxborough reservoir and $6,000 for changes at the Spring Garden boiler-house.

SOUTHERN.

Pulaski, Va.—The Pulaski Light & Water Co. was incorporated Sept. 26; capital stock, $250,000.

Perry, Ga.—Authority has been secured to issue bonds for works. The supply will probably be from an artesian well.

Washington, Ga.—Contracts have been closed for an artesian well for works.

Gainesville, Fla.—It is reported that Hartford, Hebert & Co., Chattanooga, have received the contract to build works here.

Newbern, Tenn.—Address J. I. Jones, Secretary Water Committee, regarding bids for city works. Bonds have been voted.

Ridgedale, Tenn.—A water company is talked of.

Hustonville, Ky.—Works are projected.

Pineville, Ky.—The Pineville Water Co. has been reorganized with an increased capital stock.

NORTH CENTRAL.

Ithaca, O.—The works reported last week as proposed here are for Ithaca, Mich. See below.

Princeton, Ind.—C. W. Benton, City Clerk, informs us that two applications for franchises are before the Council.

Terre Haute, Ind.—The purchase of the company's works by the city is under consideration.

Cassopolis, Mich.—A special water-works election will be held Oct. 12 to vote on bonds for works.

Ithaca, Mich.—At a special election $25,000 in bonds was voted for works.

Romeo, Mich.—B. N. Seaman, Clerk, has sent the following:

Two pumps and two boilers, with combined capacity of 1,440,000 galls., are wanted; also about 6 miles 10 to 4-in. pipe, specials, valves and 40 double hydrants.

Saginaw, Mich.—J. D. Cook, Toledo, has reported in favor of building settling reservoirs near the present east side works, to be supplied from Cass River. The west side works would be retained for emergency use.

St. Joseph, Mich.—It is reported that a vote will be taken on issuing $50,000 of bonds for works.

South Haven, Mich.—Bonds to the amount of $35,000 have been voted for works.

Illinois.—Negotiations are said to be pending with Moffett, Hodgkins & Clarke, Syracuse, N. Y., for the supply of several lake towns near Chicago, including Glencoe, Highland Park, Willmette, and Winnetka.

NORTHWESTERN.

DeWitt, Ia.—The following is from W. H. Schlabach, Clerk:

Contracts for works will probably be let by the city Oct. 25. Water will be pumped from a well 103 ft. deep to a tank on a 60-ft. brick tower. D. Armentrout is Mayor. Estimated cost $7,000.

Malvern, Ia.—The following is from J. R. Foulks, Mayor:

The city will probably let contracts soon for the works, including a supply pumped from a well to a tank. Estimated cost, $7,000.

Kearney, Neb.—The local papers are advocating the purchase of the company's works by the city.

Pierre, S. Dak.—A. W. Johnston and B. C. Ash recently applied for a franchise for works with a supply from artesian wells. The matter was referred to Aldermen Bennett and Hangan. Water is already supplied by a company.

SOUTHWESTERN.

Brookfield, Mo.—The prospecting for water has resulted satisfactorily. Twelve wells, in all, will be driven and works built.

Cape Girardeau, Mo.—It is reported that the city will build works.

Warrensburg, Mo.—Works have been defeated by a vote of 321 to 66.

Batesville, Ark.—Address J. C. Yancey for information regarding proposed works.

Stuttgart, Ark.—It is reported that a company desires to build works.

Platonia, Tex.—Arrangements for the construction of works are reported as under way.

Hartland, Tex.—Water has been found, and it is reported that works will now be put in.

Rockdale, Tex.—The Rockdale Improvement Co. was incorporated Sept. 25; capital stock, $25,000.

Gallup, N. M.—E. Hart informs us that a supply, to be pumped from a well to a reservoir, is proposed. Estimated cost, $12,000. Nothing definite has yet been done. Population, 1,500.

PACIFIC.

Chehalis, Wash.—Seattle parties have applied for a franchise for works estimated to cost $50,000.

Colfax, Wash.—Bonds for works to the amount of $50,000 have been voted.

Milton, Ore.—The city has voted $10,000 for water-works extensions and an electric lighting plant.

Port Townsend, Wash.—The people will vote on the purchase of the company's works.

Santa Barbara, Cal.—The Mountain Water Co. was incorporated Sept. 28; capital stock, $100,000. It is proposed to tunnel into the mountain for water to supply the city. H. W. Moore and E. S. Sheffield are interested.

CANADA

Amherst, N. S.—The contract for works has been awarded to Garson & Purser, St. Catherines, for $70,000. The works must be completed by Aug. 1, 1892.

ARTESIAN WELLS.

Deckertown, N. J.—A well is being sunk, and it is reported that others are talked of.

Baxley, Ga.—A well is proposed.

Perry, Ga.—A well will be sunk for water-works.

Eufaula, Ala.—R. H. Walker, Superintendent of the Eufala Water Co., informs us that bids are wanted for sinking two artesian wells. Address Mr. Walker.

Toledo, O.—A resolution to sink a well has been referred to the Council Committee on Water Supply.

Alpena, Mich.—A well is proposed in connection with a sanitarium.

Ottawa, Ill.—Nearly enough money has been subscribed to sink a proposed well at the cemetery.

Fort Pierre, S. Dak.—It is reported that wells will be sunk on the reservation west of this place.

Fairmount, N. Dak.—A town well is wanted.

Emma, Tex.—Arrangements are being made to sink a well.

Hubbard City, Tex.—A well is talked of.

Garfield, Wash.—The city is considering a proposition to sink a well.

IRRIGATION.

Bakersfield, Cal.—A company will construct irrigation works of considerable extent to reclaim land east and southeast of this place. E. J. Baldwin is interested in the company. Work is to be started at once.

Mountain Home, Idaho.—Storage reservoirs are being built by the Mountain Home Irrigation Co.

New Companies.—Lone Tree Canal & Reservoir Co., Greeley, Col.; $10,000; to operate in Weld Co. Poplar Irrigation Co., Porterville, Cal.; $11,000; Jacob Hayes, E. H. Dale and others; to buy the South-side Tule River, Rose and Springer ditches, and extend the same. Strong's Cañon Water Co., Ogden, Utah; Charles Woodmansee, president; J. A. Boyle, Secretary and Treasurer; to build large reservoir and distribute water for irrigation. Enterprise Ditch Co., Falk's Store, Idaho; $6,000.

SEWERAGE AND MUNICIPAL.

Sewers.—*Maine.*—Fairfield. The question of sewerage is under discussion. The cost is estimated at $40,000. Surveys have been made by Mr. I. E. Getchell, of Vassalboro.

New Hampshire.—Laconia. A meeting is to be held Oct. 10 to adopt regulations in connection with the new sewerage system. The yearly expenses are estimated at $5,400.—Milford. The firm of Bartlett, Gay & Young, of Manchester, has made surveys for sewer extensions.

Massachusetts.—Revere. A town meeting is to be held Oct. 12 to consider the question of the proposed sewerage system.

New York.—Niagara Falls. The plans prepared by Mr. Johnson will shortly be submitted to the State Board of Health. The Cataract Construction Co. has given the village permission to discharge the sewage into the tunnel.—Jamaica. The Trustees are considering the sewage question.—Clinton. Mr. Scripture has been appointed engineer of the Board of Sewer Commissioners, and instructed to report upon the merits of the self-cleaning and intermittent-flushing systems of sewerage, together with a maximum and minimum estimate of cost of construction of such portion, including outfall, as is absolutely necessary if anything at all is to be done, as well as for a complete system to embrace the entire village. It is considered that the only practicable outfall for a system of sewers which should drain the entire village is that indicated by Mr. Scripture on the Oriskany Creek, and it has been decided to be the wisest plan to provide pipes of sufficient size to carry the sewage only, and to exclude all surface water.—Albany. Mr. Andrews, city engineer, has made a report on the cost of intercepting sewers and a sewage disposal system.

New Jersey.—Plainfield. The Common Council has passed a new ordinance, granting a sewer franchise to J. M. Low & Co., of Kingston, N. Y.

Virginia.—Manchester. The Waring system of sewerage has been adopted by the Street Committee, and Col. Waring has been requested to forward plans and specifications at once, so that the committee can submit its report to the Council to be ratified.

Georgia.—Columbus. It is proposed to flush the sewers every night during the dry weather.—Summerville. Mr. Wm. Kiersted, of Kansas City, Mo., will prepare plans for sewerage.—Macon. A bill has been introduced to authorize the issue of $210,000 sewerage bonds.

Colorado.—Colorado Springs. The sewer system is to be extended 12 blocks, at a cost of about $12,000. The contract has been let to R. Clough.—Denver. A sewage utilization company is being organized.

Texas.—Fort Worth. The contract for the outlet for the new sewerage system has been let to J. B. Hamilton.

Street Work.—*New York.*—Troy. The Troy Union R. R. has been directed to lay a flag and brick sidewalk on Broadway.

New Jersey.—Newark. The Superintendent of Public Works has been directed to advertise for granite and trap block and sheet asphalt paving.

Pennsylvania.—Coatesville. The Council is having granolithic paving laid on some of the principal streets.—Fort Washington. The village streets are to be improved.—Philadelphia. The cost of the proposed boulevard from the city hall to the park is estimated at $3,000,000.

Maryland.—Baltimore. Ordinances have been passed providing for about $900,000 worth of street paving.

Delaware.—Wilmington. Mr. W. R. Woodbury has been instructed to prepare specifications for paving for the Street and Sewer Department.

Georgia.—Savannah. Sheet asphalt paving is to be laid on Bull St.

Ohio.—Cincinnati. The Citizens' Street Sprinkling & Cleaning Co. has been organized; capital stock, $50,000.

Nebraska.—Hastings. An ordinance has been passed providing for street improvement and brick paving.

Washington.—Tacoma. The city attorney has been directed to prepare an ordinance to the effect that on 80-ft. streets where the ends of lots abut on streets, the sidewalk shall be 7 ft. wide from the lot line, then 13 ft. of parking on each side of the sidewalk, 7 ft. of sidewalk and a 40-ft. roadway.

Gas.—*Milwaukee, Wis.*—The Council Committee on street lights has awarded a contract to the Milwaukee Gas Light Co., for lighting the streets and supplying light to the public buildings for 5 years. The city is to pay 80 cts. per 1,000 cu. ft., and $22 a year per street lamp with a 5-ft. burner, and $25 per lamp with a 6-ft. burner.

Bonds.—San Antonio, Tex.; $50,000 for streets. Hastings, Neb.; vote on $25,000 street-improvement bond, Nov. 2. Baltimore, Md.; $3,000,000 for street paving. Port Angeles, Wash.; $60,000 for municipal improvements. Watertown, N. Y.; $20,000 for sewers and streets. Elberton, Ga.; $40,000 for electric light plant. Milton, Wash.; $10,000 for water-works and electric light.

ELECTRICAL.

Electric Light.—*Portland, Me.*—A contract for lighting for one year has been awarded to the Consolidated Electric Light Co. for $73,000. There will be 250 arc lights of 1,200 c. p.; 40 and 15 series lights of 65 and 32 c. p., and 100 Edison lights of 32 c.p. The company bid $31,500 per year for 3 years.

Peabody, Mass.—An appropriation of $47,000 has been made to establish a plant with 120 arc lights. Work will be commenced shortly.

Hammondsport, N. Y.—The Bath & Hammondsport R. R. Co. will put in a Thomson-Houston plant for lighting its premises and the village.

Latrobe, Pa.—The electric light company has been awarded a contract for lighting the streets with 28 arc lights of 2,000 c.p., at $75 per light per annum for the first 25 and $70 for all above that number.

Johnstown, Pa.—The electric light company has been awarded a 5 years' contract for 146 arc lights at $108 per light per annum.

Companies.—Attica Electric Light & Power Co., of Attica, N. Y.; A Krauss, E. B. Wallis and Lewis Benedict, $20,000; Cornwall Electric Lighting & Power Co., of Cornwall, N. Y., T. Taft, S. B. Young and H. W. Chadeayne, $15,000; Edison Electric Light & Power Co., of Jersey City, N. J., R. M. Jarvis, P. G. Van Zandt and J. D. Carscallen, $500,000 commences business with $11,000.

CONTRACTING.

Loam and Gravel.—*Boston, Mass.*—The Park Commissioners have received proposals for 12,000 cu. yds. of loam at Marine Park, and for 160,000 cu. yds. of gravel for filling the parkway: Loam. H. P. Nawn, $2 per cu. yd.; Edward Fitzgerald, $1.70; Perkins & White, $1.39. Filling, Section No. 1. Thomas Maney and De Fillipo, 54 cts. per cu. yd.; Boston & Albany R. R., 55 cts.; Section No. 2. T. Maney and De Fillipo, 78½ cts.; Rone & Wall, 78 cts.; H. P. Nawn, 90 cts.

Levees.—The following contracts have been awarded as follows by Capt. Townsend, U. S. Engineer Office, Memphis, Tenn: Robertsonville crevasse, Timothy Sullivan, Memphis, 15½ cts. per cu. yd. Greenville, Miss., levee, 130,000 yds.; Weir & Donovan, Memphis, 13¾ cts. Shipland, Miss., levee, 80,000 yds.; Scott & Gavish, Memphis, 12 2-5 cts. Illawara, La., levee, 280,000 yds; Sullivan & Mulcahy, Montgomery, Ala., 16 1-5 cts. Sunny Side, Ark., levee extension, 100,000 yds; Campbell & Garrigan, Memphis, 13¾ cts. Opossum Fork, Ark., levee, 100,000 yds.; J. M. Whitehead, Arkansas City, 25 cts. Stella, Miss., crevasse, 40,000 yds.; T. Sullivan, Memphis, 18¼ cts.

Street Work.—*Philadelphia, Pa.*—The city has awarded a contract to the Vulcanite Street Paving Co. at $1.40 per sq. yd., and 37 cts. per sq. yd. for repairs for 10 years after the first five years have expired.

Terre Haute, Ind.—Mr. F. H. Cooper, City Engineer, states that the contract for paving Wabash Ave. has been awarded to Thos W. Kinsor & Son, of Muncie, Ind., at $2.40 per sq. yd. for "Canton iron paver" brick; 5 in. limestone curbing, 80 cts. per ft. The contract for Sixth St. has also been awarded to the same contractor for $2.15 per sq. yd. for paving, 70 cts. per ft. for 4-in. limestone curb, 75 cts. per ft. for the Parkhurst combined curb and gutter. These prices include Murphy's patent grout for binder or filler.

PROPOSALS OPEN.

Irrigation Work.—*Tulare, Cal.*—Excavation, construction and completion of the Tulare Irrigation District's system of canals, including drops, road bridges and fence gates. Total earth excavation about 402,000 cu. yds., in 20 sections; about 36 drops, 40 road bridges, etc. E. Oakford, Secretary. Oct. 17.

Highways.—Macadamizing Jericho turnpike. The Queens Co. Supervisors, Court House, Long Island City. Oct. 20.

Road in Chesterfield and bridge across Swift Creek. The Board of Supervisors, Manchester, Va. Oct. 15.

Street Work.—*Hastings, Neb.*—Paving and curbing in District No. 1. The City Clerk. Oct. 21.

Wellsville, O.—Improving Third St. C. B. Maylone, City Clerk. Oct. 16.

Sewers.—*Missoula, Mont.*—The City Clerk. Oct. 26.

Street Lighting.—*Leesburg, Va.*—By gasoline or electricity. The Mayor. Oct. 15.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have built a 58-ton saddle tank engine for the Belt line at San Francisco, Cal.; they have an order from the Buffalo, Rochester & Pittsburg for 2 compound and 2 simple consolidation freight engines, and 2 eight-wheel passenger engines; also for 5 compound engines for the Pennsylania. The Schenectady Locomotive Works are building 19 engines for the Chesapeake & Ohio. The Richmond Locomotive Works are building 10 engines for the Chesapeake & Ohio. The Brooks Locomotive Works, of Dunkirk, N. Y., are building 10 twelve-wheel engines for the Great Northern.

Cars.—The Terre Haute Car Co., of Terre Haute, Ind., has an order for 50 flat cars of 60,000 lbs. capacity for the Calumet & Blue Island. The Lake Shore & Michigan Southern will add 50 passenger, 10 combination, 1,000 box and 800 coal and flat cars to its equipment. The Buffalo, Rochester & Pittsburg will purchase 300 hopper bottom gondolas and 100 box cars all of 60,000 lbs. capacity.

Shailer & Schniglau, of Chicago, have been awarded the contract for piling and timber work around interior water ways at Jackson Park for the Columbian Exposition; they have also the contract for a 9 ft. tunnel under the Chicago River, at Ashland Ave., for the city of Chicago.

The Westinghouse Electric & Manufacturing Co. will receive, through August Belmont & Co., of New York, and Lee, Higginson & Co., of Boston, subscriptions at par for $3,000,000 7% cumulative preferred stock. The authorized stock of the company is $10,000,000, of which $4,000,000 is preferred stock. The balance of this latter stock, above that now offered for sale, will remain in the treasury for future requirements. Fuller detail is shown in the advertisement in this issue. The subscription lists will be open in New York and Boston Oct. 14 to Oct. 16.

The Clayton Air Compressor Works, of New York, report an average shipment of 4 air compressors per week during the past two years. In addition to compressors for use in mining, tunneling, etc., numbers have been sold for aerating crude petroleum for fuel, elevating acids and working pneumatic riveters. Several improvements have been made, among which is the patent combined governor, which regulates the speed of the compressor and the pressure of air at the same time and without attention from the engineer in charge.

Filter.—The National Water Purifying Co. states that the largest mechanical filter in the world has been in successful operation for about six months in the Public Building of Philadelphia. It is over 20 ft. diam. and about 12 ft. high, and in the test made by the Public Building committee the filter was operated under a pressure of 125 lbs. for 48 hours without the case showing structural weakness or leaking. This filter furnishes all the water for the buildings and has a capacity of 1,250,000 galls. per 24 hours. The system is the National filter with some few modifications, and the filter case was constructed in the buildings by John Baizley, of Philadelphia. The company is the patentee of this system and is constructing a larger filter, 25 ft. diam., to furnish about 2,500,000 galls. per day.

The Loomis Improved Filter Co., of Baltimore, Md., has opened an office at 111 Broadway, New York.

The Lewis-Mercer Construction Co., New York, controls patents on sewerage and sewage disposal systems, and is prepared to build water-works, sewers, gas works, etc., either upon franchise or contract plan, or for municipalities for cash or bonds. The company has built a number of public works.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31; old rails, $21 for iron and $16.50 to $17 for steel; girder rails, $40. Pittsburg: $30; old rails, $24 for iron and $17 to $18 for steel. Chicago: $31.50 to $33; light and street rails, $32.50 to $35; old rails, $21 for iron and $14 to $16 for steel.

Track Materials.—New York; steel angle bars, 1.75 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.75 to 1.85 cts. for iron or steel; iron or steel spikes, 2.1 to 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 with hexagon nuts. Chicago: splice bars, 1.85 cts. for iron, 2 cts. for steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.75 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.95 to 2.15 cts. for tank, 2.2 to 2.3 cts. for shell, 2.45 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.15 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.05 to 2.1 cts. for tank, 2.15 cts. for shell, 2.4 to 2.55 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.1 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.15 to 2.2 cts.; sheared steel plates, 2.2 to 2.25 cts. for steel; steel plates, 2.4 to 2.6 cts. for tank, 2.75 to 3 cts. for shell, 3 to 3.5 cts. for flange; 5 to 5.5 cts. for firebox; boiler rivets, 4.25 cts.